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REPORT ON LIMITS AND TOLERANCES IN SCREW THREAD FITS

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PROGRESS REPORT OF COMMITTEE ON LIMITS AND TOLERANCES IN SCREW THREAD FITS

To the Council of The American Society of Mechanical Engineers:

The Committee on Limits and Tolerances in Screw Thread Fits was assigned by the Council of The American Society of Mechanical Engineers the task "to prescribe the permissible tolerances in the commercial manufacture of taps, dies, bolts, nuts, and screws, including the method of measuring of the same."

During the years following the appointment of this committee, many meetings have been held, and work has been done through sub-committees, involving a great amount of investigation and study.

Methods of Investigation

Careful study has been given to data already published and assistance has been secured from the U. S. Bureau of Standards, The Franklin Institute, the Navy Department, and from other sources.

A request sent to many tap makers for confidential information showing the limits allowed for their commercial work, led to a response by a number of leading manufacturers, giving such information. This was tabulated and compared. Later, some of the tap makers assisted by having over 4000 taps of commercial sizes from 1/4 in. to 2 in., secured from a number of different makers, measured for errors in lead, in order to obtain the average variation of commercial taps which are in use today.

Early in the investigation, a meeting of screw manufacturers and users was called at the headquarters of The American Society of Mechanical Engineers in New York, at which about forty representatives were present, and the matter of tolerances and limits in screws was thoroughly discussed in the light of a tentative report which this committee had prepared. This meeting resulted in the appointment of a sub-committee, consisting of Messrs. E. H. Ehrman of the Chicago Screw Company, E. A. Darling of the Draper Company, and C. B. Young, engineer of tests of the Pennsylvania Railroad Company, to coöperate with the general committee by obtaining data from the screw manufacturers.

Through this committee, and the officers of the A.S.M.E., over 5000 screws were obtained from the regular commercial stock of many different manufacturers, these representing work of various grades and sizes, and with cut and rolled threads. These screws were measured and the results tabulated.

Sample screws and nuts were prepared having varying degrees of error in diameter and lead, and from these it was determined what would be the maximum error allowable, and charts were made to show the relation of taps and screws measured to these allowable limits.

Sample gages were also made to a closer limit than those now proposed by the committee, in order to learn how close it was practicable to make commercial work. These gages were distributed without stating what the allowance was in order that the users might not be prejudiced by thinking the limits were closer than they could work to.

Received by the Council, February 15, 1918, and ordered printed. Presented at the Spring Meeting, Worcester, Mass., June 1918, of The American Society of Mechanical Engineers. All papers are subject to revision.

Comparisons have also been made with the allowances and tolerances recommended by the British Engineering Standards Committee.

The recommendations of the report are the outcome of all this study and investigation.

While separate diagrams have not been provided for manufacturers' standards and users' or consumers' standards, it is expected that manufacturers will aim to work within the zones established by the diagrams so as to produce work that will come within these limits; and that gages will be so made as to insure this result.

Allowances to be provided for are wear of tools and unavoidable imperfection of workmanship.

Gaging Systems

The gaging tools required *for the threaded hole* are:

a Threaded "go" plug of a length equal to the longest engagement of work

b Threaded "not go" plug, made short and with clearance for full and root diameters;

and *for bolt or screw:*

a Threaded "go" ring of a length equal to the longest engagement of work

b Threaded "not go" ring made short and with clearance for full and root diameters.

The study given to gaging systems has led to the conclusion that no one system is best adapted to all needs; and that for a variety of work made in moderate quantities a gage for measuring errors of diameter and lead combined in the same instrument may give the best results, while for manufacturing in large quantities a fixed gage for one size only and having separate means for measuring errors in diameter and lead may be best.

There is also the need in many cases of master gages, inspection gages and workman's gages, each so made as to suit the particular needs.

A number of designs of gages for these various purposes have been submitted to 40 prominent manufacturers and users, and following their recommendations selections have been made which are illustrated and described in this report.[1]

The illustrations, Figs. 9 to 17, give general suggestions only of what it is recommended to use as it would require too voluminous a report to fully cover the ground.

Tables for Limits and Tolerances

It is believed that eventually three grades should be established, to cover not only general work, such as is here provided, but also that of more restricted and more liberal tolerances. This report deals with limits and tolerances for general work only.

Tables covering medium-grade work for general use have been prepared for diameters from 1/4 in. to 2 in. but the formulæ can be used for sizes beyond this range. They can also be used for different numbers of threads for a given diameter within ordinary range, provided the thread is of the U. S. S. form.

The variations which affect the fit between screw and nut

[1] Reference can also be made to Report No. 38 on British Standards for Limit Gages for Screw Threads.

are those of diameter, lead, including length of engaged thread, and angle of thread, besides others of a minor character, such as the crookedness of tap, the condition of its cutting edge, the kind of metal being tapped, etc. The first three of these variations have been definitely taken into consideration in the tables included in this report, and it is believed that the allowance is sufficient to provide also for the other variations mentioned, unless they are extreme.

The effect of errors of lead on the quality of fit is proportional to the length of fit; but the effect of this is modified by the error in pitch diameter. Thus, if a tap, for e ample, is materially oversize, it can have a greater error of lead than would be the case if it were nearer to the standard size, and

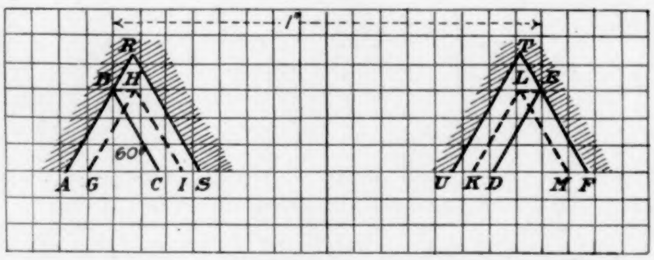


Fig. 1 Effect of Variation in Lead

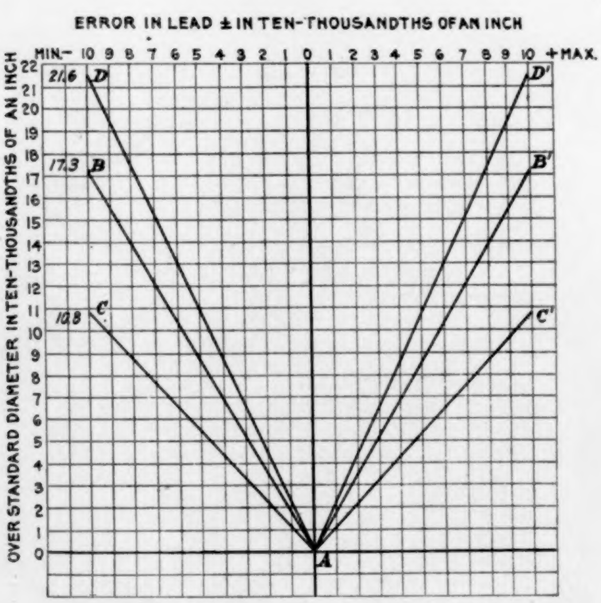


Fig. 2 Effect of Variation in Length of Fit Between Screw and Nut

still give satisfactory results in use, because the error in lead counteracts the increased diameter of the tapped hole to an extent dependent on the length of fit in the tapped hole.

The available variations, when the length of fit is not in excess of one diameter, are shown by the triangular zones of Tables 1 to 18. They are such that any screw having a diameter and error of lead which would come within such zones would enter any tapped hole which would also pass like inspection in the zone established for holes; and the extremes which would pass inspection as to looseness would not be so loose but that they would be considered mechanically satisfactory for general work.

The zones in Tables 1 to 18, as has been stated, are based on the engagement between screw and tapped hole with a length of fit equal to one diameter. If the length of fit is greater than one diameter there is a possibility of interference in *extreme cases* such as where a screw having the longest allowable lead is screwed into a hole of a depth greater than one diameter of screw, which has been tapped with a tap having the shortest allowable lead.

Under these conditions, however, unless the length considerably exceeds 1½ diameters of the screw, the flow or distortion of metal when forced by the wrench will allow the parts to be screwed together. Actual tests made under the direction of the committee show this to be so. After the first engagement, where the fit might seem unduly tight it would be materially easier,—in fact, for many uses it would be better than a shaky fit even if within the prescribed limits.

For this reason it is believed that taps, nuts and screws passing inspection within these limits, even where it is not known what length of thread may be required in actual use, can be used with the expectation that the work will be interchangeable even when the length of engagement is greater than one diameter, although theoretically there might be the interference in lead above pointed out. The keeping within the prescribed limits would be a radical improvement over the variations of taps and screws in general use today, because of a common standard serving as a "bull's-eye" at which all would aim.

If in any case it should be important to entirely avoid interference in lead, the narrower zones shown by the triangles for the larger-sized screws having a length equal to the length of fit between screw and nut to be used, will show the limiting zone. This method can be used in any case where greater accuracy is desired, and is further explained in the last three paragraphs under the heading How to Use the Tables. The plan here submitted is based on having the maximum screws basic in pitch, outside and root diameters.

Generally stated, all tapped holes should be above basic standard and all screws, below; the more above or below in pitch diameter the greater the allowance possible in error of lead, while still maintaining a satisfactory fit.

In Tables 1 to 18 the figures for taps are held to a limit slightly above the largest allowable screws to provide for wear of the tap, the greatest allowance being made at perfect lead where a reduction in diameter due to wear would be most objectionable. In applying the tables and diagrams to the use of fixed gages, a rectangle representing a given maximum and minimum in pitch diameter and a given error in lead within the triangular zone can be established. Work failing to pass inspection with such gages can be then measured for diameter and lead, and if coming within the triangular zone even though outside the limits of the gages need not be thrown out but can be accepted for use.

Charts and Tables for Limits and Tolerances Shown in Tables 1 to 18, Inclusive

When a screw or nut has an error in lead, the amount of that error varies directly as the length of thread on screw or depth of threaded hole, i.e., the longer the screw or the deeper the hole, the greater the total error in lead; and where a definite quality of fit between a screw and nut is desired, less error in lead per inch can be allowed for a long thread than for a short one.

In these tables and charts, therefore, the length of thread is made the governing feature and any chart applies equally well to a screw or nut of any diameter or pitch, for the length of thread specified.

The limits for the lengths of threads as adopted and shown

by the charts are 0 for the minimum limit and once the nominal diameter of U. S. S. thread for the maximum limit. In this way each chart is especially applicable to a definite size and becomes a standard for that size between the lengths of thread specified.

Another factor in the fit between a screw and nut is the pitch diameter measured on the "V" of the thread. For a 60-deg. thread of a *given length* the error in pitch diameter bears a definite relation to the error in lead.

This is illustrated in Fig. 1 where *ABC* and *DEF* represent two threads 1 in. apart on a standard thread gage. Let *GHI* and *KLM* represent two actual spaces cut by a tap of the same pitch diameter with an error in lead equal to *BH* and *LE*. Then the stock *ABHG* and *LMEF* would interfere with the entrance of the threaded gage. But if the tap was increased in radius by the amount *RH*, its lead remaining the same, then it would cut the spaces *ARS* and *UTF* and the thread gage would enter full length and bear along the surfaces *AB* and *FE*.

From this it follows that to obtain a fit for a definite length of thread the pitch diameter can be made to compensate for any error in lead within reasonable limits.

This relation between the pitch diameter and lead, when *plotted* on the chart, becomes a straight line.

In Fig. 2 a tap or screw with perfect lead and pitch diameter would fall at the intersection of the two zero lines at *A* and, we will assume, would cut a perfect thread for a threaded hole 1 in. deep, i.e., a hole in which a standard threaded plug gage would fit.

Another tap having an error in lead of 0.0010 in. per inch

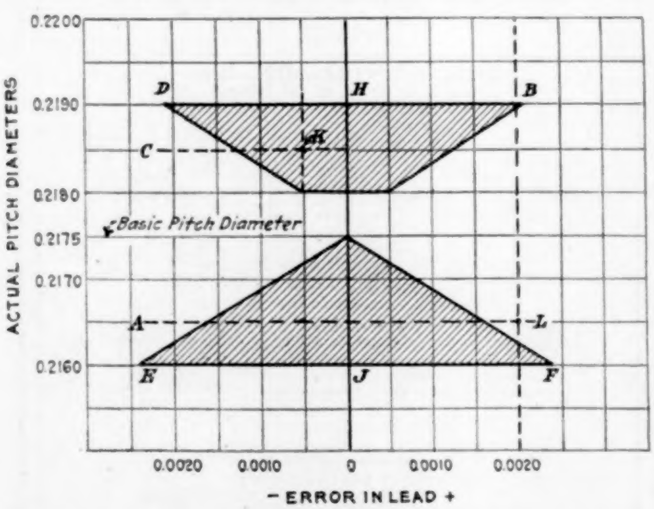


FIG. 3 DIAGRAM ILLUSTRATING METHOD OF USING CHARTS SHOWN IN TABLES 1 TO 18

but having an increased pitch diameter of 0.00173 in. would fall at *B′* and for a hole 1 in. deep would be the equivalent of the first tap. If two nuts 1 in. thick were tapped one with each of these taps, a standard threaded plug gage when clear through the nut would fit with equal shake in both nuts.

The line *AB′* passing through zero represents *all* oversize threads 1 in. long with a long or plus lead that are equivalent to a standard or perfect thread. The line *AB* similarly represents *all* oversize threads 1 in. long with a short or minus lead.[1]

The lines *AC* and *AC′* represent taps equivalent to standard for threads 5/8 in. long and *AD* and *AD′* for threads 1.25 in. long, the amounts over standard for *CC′* and *DD′* being respectively 3/8 and 1 1/4 times *B* (17.3) for a lead error of 0.001 in.

The oblique lines on the charts, Tables 1 to 18, are similar lines for the maximum length of thread specified in the table

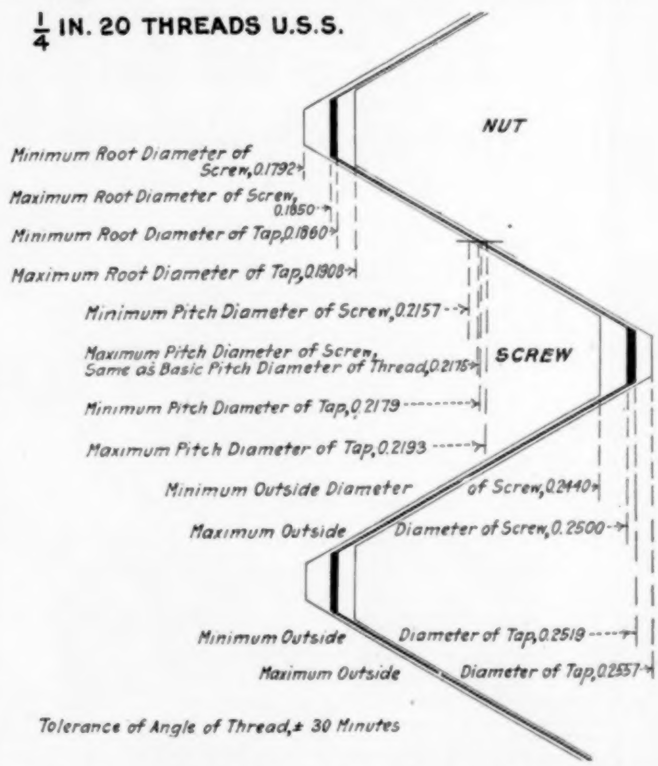


FIG. 4 RELATION OF SCREW AND NUT, SHOWING MAXIMUM AND MINIMUM ALLOWANCES

alongside of each chart. For screws these lines pass through zero and represent equivalents of perfect screws. For taps and nuts these lines pass through a point slightly above the zero point in order to keep all taps and nuts slightly over standard.

In Fig. 3, the points *HJ* where the upper and lower lines intersect the perfect lead line, represent the extreme limits for the pitch diameters of a nut and screw with perfect lead, and the distance between these two points represents the maximum diametrical shake between any nut and screw falling within the shaded areas or zones of the chart, while the average shake would be about one-half of this maximum shake.

It is assumed that a tap makes a hole the exact counterpart of itself, therefore taps and nuts are referred to as having identically the same pitch diameter and lead.

HOW TO USE THE TABLES

For a Tap:

a Find the actual pitch diameter of the tap with a "V"-thread micrometer. Look in left-hand column at the bottom of the table for taps for the required size (Tables 1 to 18) for this diameter. If the diameter is less than the first figure or greater than the last figure of the column, the tap is not within the limits required.

b When the diameter is found in the table, read to the right in the next column the amount it is *over basic* pitch diameter. Read again to the right in the third column the allowable "errors in lead" for this pitch diameter.

[1] The shorter the length of thread the more nearly horizontal this line becomes, and for a zero length of thread it becomes horizontal, coinciding with the horizontal zero line *OA*. Similarly the greater the length of thread the more nearly vertical this line becomes.

1/4 (0.250) INCH 20 THREADS U.S.S.

BASIC PITCH DIAMETER 0.2175

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 16 PITCH TOOL=0.0069		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 22 PITCH TOOL=0.0057	
	MIN.	MAX.		MAX.	MIN.
OUTSIDE DIAMETER	0.2519	0.2557	0.2500	0.2500	0.2440
ROOT "	0.1867	0.1877	0.1850	0.1850	0.1792

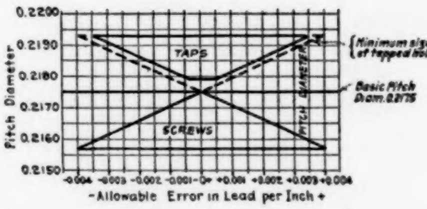
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 0.2193	MAX 0.2193	0.0035	0.0035	0.2157 MIN.
MIN. 0.2179	MIN 0.2175	0.0004	0.0000	0.2175 MAX.

Tolerance for Thread Angle ± 30 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT 0 TO 1/4 INCH (ONCE THE DIAM.)

NOTE: In Practice these can be recommended for length of thread engagement to one and one half diam's (3/8") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE (READ FROM LEFT TO RIGHT)

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
0.2179	0.0004	±0.0005	±0.0009
0.2180	0.0005	±0.0007	±0.0011
0.2185	0.0010	±0.0018	±0.0022
0.2190	0.0015	±0.0029	±0.0033
0.2193	0.0018	±0.0035	±0.0040

FOR A SCREW OR BOLT (READ FROM RIGHT TO LEFT)

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM.
0.0000	0.0000	0.2175
±0.0012	0.0005	0.2170
±0.0022	0.0010	0.2165
±0.0033	0.0015	0.2160
±0.0040	0.0018	0.2157

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TABLE 1

5/16 (0.3125) INCH 18 THREADS U.S.S.

BASIC PITCH DIAMETER 0.2764

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 16 PITCH TOOL=0.0078		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 20 PITCH TOOL=0.0062	
	MIN.	MAX.		MAX.	MIN.
OUTSIDE DIAMETER	0.3144	0.3186	0.3125	0.3125	0.3059
ROOT "	0.2414	0.2464	0.2403	0.2403	0.2342

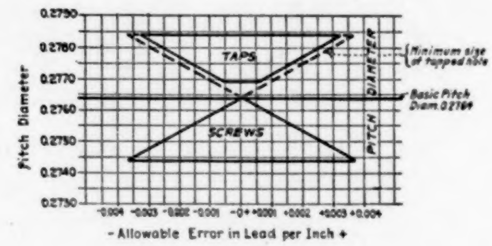
LIMITS ON PITCH DIAMETER AT PERFECT LEAD.

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 0.2784	MAX. 0.2784	0.0040	0.0040	0.2744 MIN.
MIN. 0.2769	MIN. 0.2764	0.0005	0.0000	0.2764 MAX.

Tolerance for Thread Angle ± 30 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO 5/16 INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's (15/32") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE (READ FROM LEFT TO RIGHT)

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
0.2769	0.0005	±0.0006	±0.0010
0.2770	0.0006	±0.0008	±0.0011
0.2775	0.0011	±0.0016	±0.0021
0.2780	0.0016	±0.0025	±0.0030
0.2784	0.0020	±0.0033	±0.0037

FOR A SCREW OR BOLT (READ FROM RIGHT TO LEFT)

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM.
±0.0000	0.0000	0.2764
±0.0008	0.0004	0.2760
±0.0017	0.0009	0.2755
±0.0027	0.0014	0.2750
±0.0037	0.0019	0.2744

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TABLE 2

3/8 (0.375) INCH 16 THREADS U.S.S.

BASIC PITCH DIAMETER 0.3344

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 14 PITCH TOOL=0.0089		U.S.S BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 18 PITCH TOOL=0.0069	
	MIN	MAX		MAX.	MIN.
OUTSIDE DIAMETER	0.3770	0.3815	0.3750	0.3750	0.3677
ROOT "	0.2949	0.3001	0.2936	0.2936	0.2871

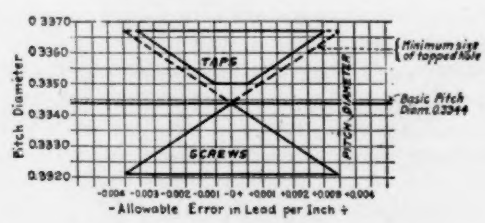
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 0.3367	MAX. 0.3367	0.0046	0.0046	0.3321 MIN.
MIN 0.3347	MIN. 0.3344	0.0003	0.0003	0.3344 MAX.

Tolerance for Thread Angle ± 30 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO 3/8 INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's (9/16") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE (READ FROM LEFT TO RIGHT)

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
0.3350	0.0006	±0.0005	±0.0009
0.3355	0.0011	±0.0013	±0.0017
0.3360	0.0016	±0.0020	±0.0024
0.3365	0.0021	±0.0028	±0.0032
0.3367	0.0023	±0.0031	±0.0035

FOR A SCREW OR BOLT (READ FROM RIGHT TO LEFT)

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
±0.0000	0.0000	0.3344
±0.0006	0.0004	0.3340
±0.0014	0.0009	0.3335
±0.0021	0.0014	0.3330
±0.0029	0.0019	0.3325
±0.0035	0.0023	0.3321

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TABLE 3

7/16 (0.4375) INCH 14 THREADS U.S.S.

BASIC PITCH DIAMETER 0.3911

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 13 PITCH TOOL=0.0096		USS BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 16 PITCH TOOL=0.0078	
	MIN.	MAX.		MAX.	MIN.
OUTSIDE DIAMETER	0.4396	0.4444	0.4375	0.4375	0.4292
ROOT "	0.3461	0.3516	0.3447	0.3447	0.3378

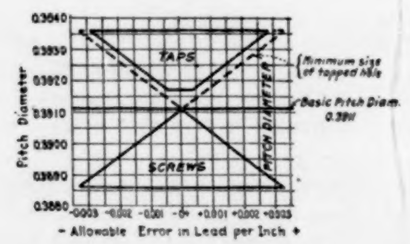
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 0.3936	MAX 0.3936	0.0050	0.0050	0.3886 MIN
MIN. 0.3917	MIN. 0.3911	0.0006	0.0000	0.3911 MAX

Tolerance for Thread Angle ± 30 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO 7/16 INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's (21/32") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE (READ FROM LEFT TO RIGHT)

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
0.3917	0.0006	±0.0004	±0.0008
0.3920	0.0009	±0.0008	±0.0012
0.3925	0.0014	±0.0015	±0.0019
0.3930	0.0019	±0.0021	±0.0025
0.3935	0.0024	±0.0029	±0.0032
0.3936	0.0025	±0.0033	±0.0038

FOR A SCREW OR BOLT (READ FROM RIGHT TO LEFT)

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
±0.0000	0.0000	0.3911
±0.0008	0.0006	0.3905
±0.0015	0.0011	0.3900
±0.0021	0.0016	0.3895
±0.0028	0.0021	0.3890
±0.0033	0.0025	0.3886

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TABLE 4

$\frac{1}{2}$ (0.500) INCH 13 THREADS U.S.S.
BASIC PITCH DIAMETER 0.4501

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 12 PITCH TOOL=0.0104		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 14 PITCH TOOL=0.0089	
	MIN.	MAX.		MAX.	MIN.
OUTSIDE DIAMETER	0.5021	0.5073	0.5000	0.5000	0.4911
ROOT "	0.4016	0.4074	0.4001	0.4001	0.3928

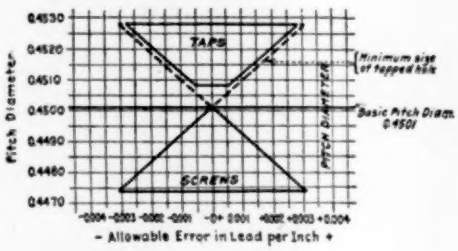
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 0.4528	MAX. 0.4528	0.0054	0.0054	0.4474 MIN.
MIN. 0.4508	MIN. 0.4501	0.0007	0.0000	0.4501 MAX.

Tolerance for Thread Angle ± 30 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $\frac{1}{2}$ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($\frac{3}{4}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25.



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM.	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
0.4508	0.0007	±0.0006	±0.0008
0.4510	0.0009	±0.0009	±0.0010
0.4515	0.0014	±0.0013	±0.0016
0.4520	0.0019	±0.0020	±0.0022
0.4525	0.0024	±0.0025	±0.0028
0.4528	0.0027	±0.0028	±0.0031

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM.
±0.0000	0.0000	0.4501
±0.0007	0.0006	0.4495
±0.0013	0.0011	0.4490
±0.0018	0.0016	0.4485
±0.0024	0.0021	0.4480
±0.0030	0.0026	0.4475
±0.0031	0.0027	0.4474

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TABLE 5

$\frac{9}{16}$ (0.5625) INCH 12 THREADS U.S.S.
BASIC PITCH DIAMETER 0.5084

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 11 PITCH TOOL=0.0114		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 13 PITCH TOOL=0.0096	
	MIN.	MAX.		MAX.	MIN.
OUTSIDE DIAMETER	0.5646	0.5701	0.5625	0.5625	0.5530
ROOT "	0.4559	0.4618	0.4542	0.4542	0.4466

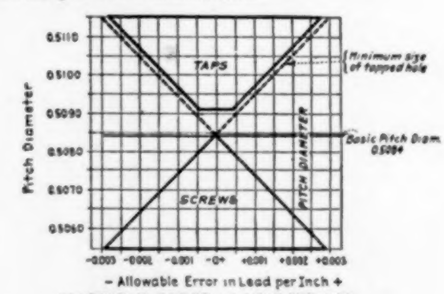
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 0.5112	MAX. 0.5112	0.0056	0.0056	0.5056 MIN.
MIN. 0.5091	MIN. 0.5084	0.0007	0.0000	0.5084 MAX.

Tolerance for Thread Angle ± 30 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $\frac{9}{16}$ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($\frac{27}{32}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLES
0.5091	0.0007	±0.0005	±0.0007
0.5095	0.0011	±0.0009	±0.0011
0.5100	0.0016	±0.0014	±0.0016
0.5105	0.0021	±0.0019	±0.0022
0.5110	0.0026	±0.0025	±0.0027
0.5113	0.0033	±0.0027	±0.0029

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
±0.0000	0.0000	0.5084
±0.0004	0.0004	0.5080
±0.0010	0.0009	0.5075
±0.0015	0.0014	0.5070
±0.0020	0.0019	0.5065
±0.0025	0.0024	0.5060
±0.0029	0.0029	0.5055

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TABLE 6

$\frac{5}{8}$ (0.625) INCH 11 THREADS U.S.S.
BASIC PITCH DIAMETER 0.5660

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 10 PITCH TOOL=0.0125		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 12 PITCH TOOL=0.0104	
	MIN.	MAX.		MAX.	MIN.
OUTSIDE DIAMETER	0.6272	0.6330	0.6250	0.6250	0.6147
ROOT "	0.5087	0.5148	0.5069	0.5069	0.4990

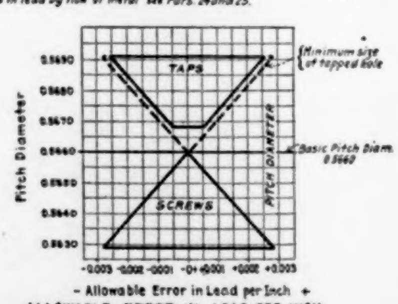
LIMITS ON PITCH DIAMETER AT PERFECT LEAD.

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 0.5691	MAX. 0.5691	0.0062	0.0062	0.5629 MIN.
MIN. 0.5668	MIN. 0.5660	0.0008	0.0000	0.5660 MAX.

Tolerance for Thread Angle ± 15' Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $\frac{5}{8}$ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($\frac{15}{16}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25.



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM.	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
0.5668	0.0008	±0.0006	±0.0008
0.5670	0.0010	±0.0008	±0.0009
0.5675	0.0015	±0.0012	±0.0014
0.5680	0.0020	±0.0016	±0.0018
0.5685	0.0025	±0.0021	±0.0023
0.5690	0.0030	±0.0025	±0.0027
0.5691	0.0031	±0.0026	±0.0028

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM.
0.0000	0.0000	0.5660
±0.0005	0.0005	0.5655
±0.0009	0.0010	0.5650
±0.0014	0.0015	0.5645
±0.0018	0.0020	0.5640
±0.0023	0.0025	0.5635
±0.0027	0.0030	0.5630
±0.0028	0.0031	0.5629

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TABLE 7

$\frac{3}{4}$ (0.750) INCH 10 THREADS U.S.S.
BASIC PITCH DIAMETER 0.6851

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 9 PITCH TOOL=0.0139		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 11 PITCH TOOL=0.0114	
	MIN	MAX		MAX	MIN.
OUTSIDE DIAMETER	0.7522	0.7585	0.7500	0.7500	0.7387
ROOT "	0.6221	0.6284	0.6201	0.6201	0.6118

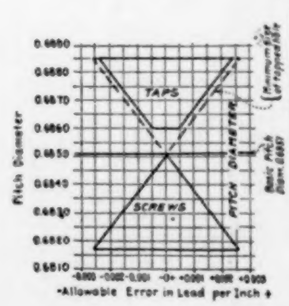
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 0.6885	MAX. 0.6885	0.0068	0.0068	0.6817 MIN
MIN. 0.6860	MIN. 0.6851	0.0009	0.0000	0.6851 MAX

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $\frac{3}{4}$ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($1\frac{1}{8}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
0.6860	0.0009	±0.0005	±0.0007
0.6865	0.0014	±0.0009	±0.0011
0.6870	0.0019	±0.0012	±0.0015
0.6875	0.0024	±0.0016	±0.0018
0.6880	0.0029	±0.0020	±0.0022
0.6885	0.0034	±0.0024	±0.0026

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM.
0.0000	0.0000	0.6851
±0.0005	0.0006	0.6845
±0.0009	0.0011	0.6840
±0.0012	0.0016	0.6835
±0.0016	0.0021	0.6830
±0.0020	0.0026	0.6825
±0.0024	0.0031	0.6820
±0.0026	0.0034	0.6817

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TABLE 8

$\frac{7}{8}$ (0.875) INCH 9 THREADS U.S.S.

BASIC PITCH DIAMETER 0.8029

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 8 PITCH TOOL=0.0156		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 10 PITCH TOOL=0.0125	
	MIN.	MAX.		MAX.	MIN.
OUTSIDE DIAMETER	0.8773	0.8840	0.8750	0.8750	0.8625
ROOT "	0.7329	0.7395	0.7307	0.7307	0.7219

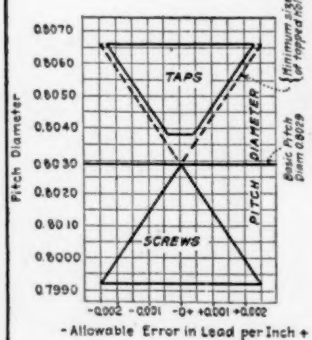
LIMITS ON PITCH DIAMETER AT PERFECT LEAD.

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 0.8066	MAX. 0.8066	0.0054	0.0054	0.8012 MIN.
MIN. 0.8038	MIN. 0.8029	0.0009	0.0000	0.8029 MAX.

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $\frac{7}{8}$ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($1\frac{5}{16}$) because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25.



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH: TAP	ALLOWABLE ERROR IN LEAD PER INCH: TAPPED HOLE
0.8038	0.0009	±0.0004	±0.0006
0.8040	0.0011	±0.0005	±0.0008
0.8045	0.0016	±0.0009	±0.0011
0.8050	0.0021	±0.0012	±0.0015
0.8055	0.0026	±0.0016	±0.0018
0.8060	0.0031	±0.0019	±0.0021
0.8065	0.0036	±0.0022	±0.0024
0.8066	0.0037	±0.0023	±0.0025

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM.
±0.0000	0.0000	0.8029
±0.0003	0.0004	0.8025
±0.0006	0.0009	0.8020
±0.0010	0.0014	0.8015
±0.0013	0.0019	0.8010
±0.0016	0.0024	0.8005
±0.0020	0.0029	0.8000
±0.0023	0.0034	0.7995
±0.0025	0.0037	0.7992

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TABLE 9

1 INCH 8 THREADS U.S.S.

BASIC PITCH DIAMETER 0.9188

Outside and Root Measurements.

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 7 PITCH TOOL=0.0179		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 9 PITCH TOOL=0.0139	
	MIN.	MAX.		MAX.	MIN.
OUTSIDE DIAMETER	1.0023	1.0092	1.0000	1.0000	0.9861
ROOT "	0.8401	0.8469	0.8376	0.8376	0.8283

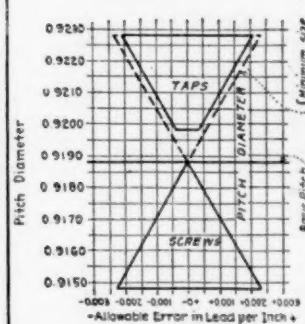
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 0.9228	MAX. 0.9228	0.0080	0.0080	0.9148 MIN.
MIN. 0.9198	MIN. 0.9188	0.0010	0.0000	0.9188 MAX.

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO 1 INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($1\frac{1}{2}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25.



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH: TAP	ALLOWABLE ERROR IN LEAD PER INCH: TAPPED HOLE
0.9198	0.0010	±0.0004	±0.0006
0.9200	0.0012	±0.0005	±0.0007
0.9205	0.0017	±0.0008	±0.0010
0.9210	0.0022	±0.0011	±0.0013
0.9215	0.0027	±0.0014	±0.0016
0.9220	0.0032	±0.0017	±0.0019
0.9225	0.0037	±0.0019	±0.0022
0.9228	0.0040	±0.0021	±0.0023

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM.
0.0000	0.0000	0.9188
±0.0002	0.0003	0.9185
±0.0005	0.0008	0.9180
±0.0008	0.0013	0.9175
±0.0010	0.0018	0.9170
±0.0013	0.0023	0.9165
±0.0016	0.0028	0.9160
±0.0019	0.0033	0.9155
±0.0022	0.0038	0.9150
±0.0023	0.0040	0.9148

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TABLE 10

$1\frac{1}{8}$ (1.125) INCH 7 THREADS U.S.S.

BASIC PITCH DIAMETER 1.0322

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 6 PITCH TOOL=0.0208		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 8 PITCH TOOL=0.0156	
	MIN	MAX		MAX.	MIN.
OUTSIDE DIAMETER	1.1274	1.1347	1.1250	1.1250	1.1093
ROOT "	0.9422	0.9494	0.9394	0.9394	0.9294

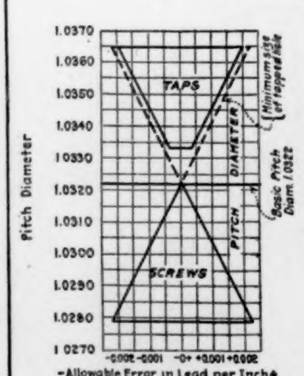
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 1.0365	MAX. 1.0365	0.0086	0.0086	1.0279 MIN.
MIN. 1.0333	MIN. 1.0322	0.0011	0.0000	1.0322 MAX.

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $1\frac{1}{8}$ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($1\frac{11}{16}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25.



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM.	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH: TAP	ALLOWABLE ERROR IN LEAD PER INCH: TAPPED HOLE
1.0333	0.0011	±0.0004	±0.0006
1.0335	0.0013	±0.0005	±0.0007
1.0340	0.0018	±0.0007	±0.0009
1.0345	0.0023	±0.0010	±0.0012
1.0350	0.0028	±0.0012	±0.0014
1.0355	0.0033	±0.0015	±0.0017
1.0360	0.0038	±0.0018	±0.0020
1.0365	0.0043	±0.0020	±0.0022

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
±0.0000	0.0000	1.0322
±0.0004	0.0007	1.0315
±0.0006	0.0012	1.0310
±0.0009	0.0017	1.0305
±0.0011	0.0022	1.0300
±0.0014	0.0027	1.0295
±0.0016	0.0032	1.0290
±0.0019	0.0037	1.0285
±0.0021	0.0042	1.0280
±0.0022	0.0043	1.0279

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TABLE 11

$1\frac{1}{4}$ (1.250) INCH 7 THREADS U.S.S.

BASIC PITCH DIAMETER 1.1572

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 6 PITCH TOOL=0.0208		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 8 PITCH TOOL=0.0156	
	MIN.	MAX.		MAX.	MIN.
OUTSIDE DIAMETER	1.2524	1.2605	1.2500	1.2500	1.2343
ROOT "	1.0673	1.0744	1.0644	1.0644	1.0544

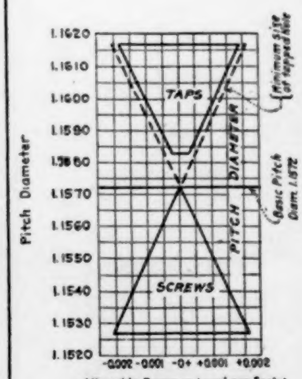
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 1.1617	MAX. 1.1617	0.0090	0.0090	1.1527 MIN.
MIN. 1.1583	MIN. 1.1572	0.0011	0.0000	1.1572 MAX.

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO $1\frac{1}{4}$ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's ($1\frac{7}{8}$") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25.



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE — READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM.	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH: TAP	ALLOWABLE ERROR IN LEAD PER INCH: TAPPED HOLE
1.1583	0.0011	±0.0003	±0.0005
1.1585	0.0013	±0.0004	±0.0006
1.1590	0.0018	±0.0006	±0.0008
1.1595	0.0023	±0.0009	±0.0011
1.1600	0.0028	±0.0011	±0.0013
1.1605	0.0033	±0.0013	±0.0015
1.1610	0.0038	±0.0016	±0.0018
1.1615	0.0043	±0.0018	±0.0020
1.1617	0.0045	±0.0019	±0.0021

FOR A SCREW OR BOLT — READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
±0.0000	0.0000	1.1572
±0.0003	0.0007	1.1565
±0.0006	0.0012	1.1560
±0.0008	0.0017	1.1555
±0.0010	0.0022	1.1550
±0.0013	0.0027	1.1545
±0.0015	0.0032	1.1540
±0.0017	0.0037	1.1535
±0.0020	0.0042	1.1530
±0.0021	0.0045	1.1527

TABLE 12

1⅜ (1.375) INCH 6 THREADS U.S.S.
BASIC PITCH DIAMETER 1.2668
Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 5½ PITCH TOOL=0.0227		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 7 PITCH TOOL=0.0179	
	MIN.	MAX.		MAX	MIN
OUTSIDE DIAMETER	1.3777	1.3865	1.3750	1.3750	1.3568
ROOT "	1.1618	1.1695	1.1585	1.1585	1.1475

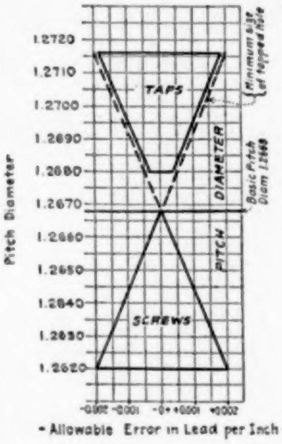
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 1.2716	MAX. 1.2716	0.0096	0.0096	1.2620 MIN.
MIN. 1.2680	MIN. 1.2668	0.0012	0.0000	1.2668 MAX.

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT 0 TO 1⅜ INCH (ONCE THE DIAM.)

NOTE: In Practice these can be recommended for length of thread engagement to one and one half diam's (2 1/16") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25.



ALLOWABLE ERRORS IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR A TAPPED HOLE
READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM.	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
1.2680	0.0012	±0.0004	±0.0005
1.2685	0.0017	±0.0006	±0.0007
1.2690	0.0022	±0.0008	±0.0009
1.2695	0.0027	±0.0010	±0.0011
1.2700	0.0032	±0.0012	±0.0014
1.2705	0.0037	±0.0014	±0.0016
1.2710	0.0042	±0.0016	±0.0018
1.2715	0.0047	±0.0018	±0.0020
1.2716	0.0048	±0.0019	±0.0020

FOR A SCREW OR BOLT
READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM.
±0.0000	0.0000	1.2668
±0.0003	0.0008	1.2660
±0.0005	0.0013	1.2655
±0.0007	0.0018	1.2650
±0.0010	0.0023	1.2645
±0.0012	0.0028	1.2640
±0.0014	0.0033	1.2635
±0.0016	0.0038	1.2630
±0.0018	0.0043	1.2625
±0.0020	0.0048	1.2620

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TABLE 13

1½ (1.500) INCH 6 THREADS U.S.S.
BASIC PITCH DIAMETER 1.3918
Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 5½ PITCH TOOL=0.0227		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 7 PITCH TOOL=0.0179	
	MIN.	MAX.		MAX.	MIN.
OUTSIDE DIAMETER	1.5024	1.5115	1.5000	1.5000	1.4818
ROOT "	1.2868	1.2944	1.2835	1.2835	1.2726

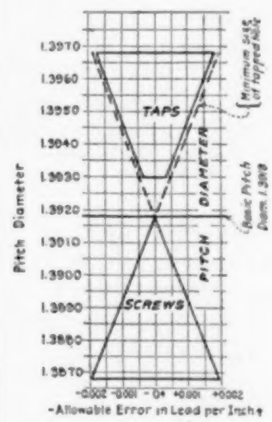
LIMITS ON PITCH DIAMETER AT PERFECT LEAD.

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 1.3968	MAX. 1.3968	0.0100	0.0100	1.3868 MIN.
MIN. 1.3931	MIN. 1.3918	0.0013	0.0000	1.3918 MAX.

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO 1½ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's (2¼") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25.



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE
READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM.	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
1.3930	0.0012	±0.0004	±0.0005
1.3940	0.0022	±0.0008	±0.0009
1.3950	0.0032	±0.0011	±0.0012
1.3960	0.0040	±0.0015	±0.0016
1.3968	0.0050	±0.0018	±0.0019

FOR A SCREW OR BOLT
READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
±0.0000	0.0000	1.3918
±0.0003	0.0008	1.3910
±0.0007	0.0018	1.3900
±0.0011	0.0028	1.3890
±0.0014	0.0038	1.3880
±0.0018	0.0048	1.3870
±0.0019	0.0050	1.3868

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TABLE 14

1⅝ (1.625) INCH 5½ PITCH U.S.S.
BASIC PITCH DIAMETER 1.5069
Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 5 PITCH TOOL=0.0250		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 6 PITCH TOOL=0.0208	
	MIN.	MAX.		MAX.	MIN.
OUTSIDE DIAMETER	1.6278	1.6375	1.6250	1.6250	1.6053
ROOT "	1.3924	1.4003	1.3888	1.3888	1.3773

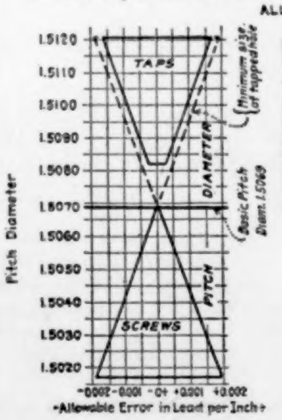
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 1.5121	MAX. 1.5121	0.0104	0.0104	1.5017 MIN.
MIN. 1.5082	MIN. 1.5069	0.0013	0.0000	1.5069 MAX.

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO 1⅝ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's (2 7/16") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25.



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE
READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM.	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
1.5082	0.0013	±0.0003	±0.0005
1.5090	0.0021	±0.0006	±0.0008
1.5100	0.0031	±0.0009	±0.0011
1.5110	0.0041	±0.0013	±0.0015
1.5120	0.0051	±0.0016	±0.0019
1.5121	0.0052	±0.0017	±0.0019

FOR A SCREW OR BOLT
READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM.
±0.0000	0.0000	1.5069
±0.0004	0.0009	1.5060
±0.0007	0.0019	1.5050
±0.0011	0.0029	1.5040
±0.0014	0.0039	1.5030
±0.0018	0.0049	1.5020
±0.0019	0.0052	1.5017

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TABLE 15

1¾ (1.750) INCH 5 THREADS U.S.S.
BASIC PITCH DIAMETER 1.6201
Outside and Root Measurements.

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 4½ PITCH TOOL=0.0278		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 5½ PITCH TOOL=0.0227	
	MIN.	MAX.		MAX.	MIN.
OUTSIDE DIAMETER	1.7525	1.7630	1.7500	1.7500	1.7284
ROOT "	1.4942	1.5024	1.4902	1.4902	1.4780

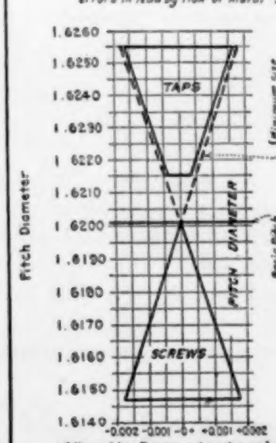
LIMITS ON PITCH DIAMETER AT PERFECT LEAD.

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 1.6256	MAX. 1.6256	0.0109	0.0109	1.6147 MIN.
MIN. 1.6215	MIN. 1.6201	0.0014	0.0000	1.6201 MAX.

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO 1¾ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's (2⅝") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25.



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE
READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM.	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
1.6215	0.0014	±0.0004	±0.0005
1.6225	0.0024	±0.0007	±0.0008
1.6235	0.0034	±0.0010	±0.0011
1.6245	0.0044	±0.0014	±0.0015
1.6255	0.0054	±0.0017	±0.0018

FOR A SCREW OR BOLT
READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM.
0.0000	0.0000	1.6201
±0.0002	0.0006	1.6195
±0.0005	0.0016	1.6185
±0.0009	0.0026	1.6175
±0.0012	0.0036	1.6165
±0.0016	0.0046	1.6155
±0.0018	0.0054	1.6147

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TABLE 16

c Next find the actual error in lead per inch with some lead-measuring instrument. If the actual error is within the limits given in the third column, then the tap is correct for both pitch diameter and lead.

Example: For ¼ in., 20 thread tap, for threads from 0 to ¼ in. long, refer to Table 1 and under "For a Tap or Nut." Suppose the pitch diameter of a tap is 0.2185 in. Find this figure in the first column; to the right the next column shows the tap as 0.0010 in. over basic pitch diameter, and the third column shows that its lead must be between 0.0018 in. fine (minus) to 0.0018 in. coarse (plus) per inch to be within the limits of this table.

For a Screw:

d Find the actual pitch diameter of the screw with a "V"-thread micrometer. Look in the last column at the bottom of the table for screws for the required size (Tables 1 to 18) for this diameter. If the diameter is less than the first figure or greater than the last figure in the column, the screw is not within the limits required.

e When the diameter is found, read to the left in the next column to the left the amount that it is *under basic* pitch diameter. Read again in the third column to the left the allowable error in lead for this pitch diameter.

f Next find the actual error in lead per inch with some lead-measuring instrument. If the actual error is within the limits given in the third column to the left, then the screw is correct for both pitch diameter and lead.

Example: For ¼ in., 20 thread screw, for threads from 0 to ¼ in. long refer to Table 1, and under "For a Screw or Bolt." Suppose the pitch diameter of a screw is 0.2160 in. Find this figure in the last column; the next column to the left shows the screw as 0.0015 in. under basic pitch diameter, and the third column to the left shows that its lead must be between 0.0033 in. fine (minus) and 0.0033 in. coarse (plus) to be within the limits of the table.

For Screws and Taps:

g If the actual pitch diameter for either tap or screw is within the range of the tables, but the exact diameter is not given in the proper column, it can be interpolated, or reckoned as between the two nearest values given, and a proportionate and corresponding limit can be likewise interpolated in order to find the error in lead allowable for the actual pitch diameter in hand.

Example: Same table. Suppose the pitch diameter of a tap is 0.2188 in. In the first column for taps it would come between 0.2185 in, and 0.2190 in. and the value for the next column would be ⅗ of the way between 0.0010 and 0.0015 in. or 0.0013 in., and the value for the third column would be ⅗ of the way between 0.0018 in. and 0.0029 in., or 0.0025 in.

If the length of engagement is greater than that provided for in the tables, reference can be made to the table for a larger size having the required length, and the allowable variations in lead thus found.

Example: Suppose a ¼-in. 20 screw is to extend into a tapped hole for a depth of ½ in., or two diameters. Refer to the diagram Table 5 for a hole ½ in. deep, this being for ½ in. 13, which allows for a fit ½ in. long. This will show by the angular lines what variations in lead are allowable, bearing in mind that the variations in pitch diameter must still be kept within the limits given in Table 1 for ¼ in.

Example: Suppose a 1-in. 8 bolt is to be used with a nut ¾ in. thick. Refer to the diagram Table 8, which allows for a fit ¾ in. long. This allows for a greater variation in lead than the diagram for 1 in., Table 10. The greater limits in pitch diameter allowed for 1 in. can also be used, however.

$1\frac{7}{8}$ (1.875) INCH 5 PITCH U.S.S.

BASIC PITCH DIAMETER 1 7451

Outside and Root Measurements

	FOR A TAP OR NUT FLAT AT BOTTOM OF THREAD SAME AS 4½ PITCH TOOL=0.0278		U.S.S. BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 5½ PITCH TOOL=0.0227	
	MIN.	MAX.		MAX.	MIN.
OUTSIDE DIAMETER	1.8775	1.8880	1.8750	1.8750	1.8534
ROOT "	1.6192	1.6273	1.6152	1.6152	1.6031

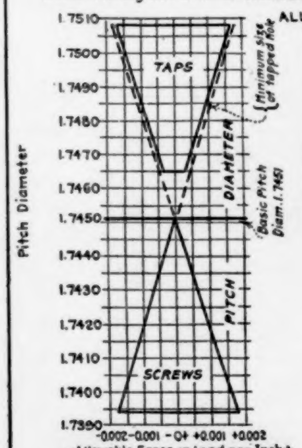
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 1.7508	MAX. 1.7508	0.0114	0.0114	1.7394 MIN.
MIN. 1.7465	MIN. 1.7451	0.0014	0.0000	1.7451 MAX.

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO 1⅞ INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's (2 13/16") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
1.7465	0.0014	±0.0003	±0.0004
1.7470	0.0019	±0.0005	±0.0006
1.7480	0.0029	±0.0008	±0.0009
1.7490	0.0039	±0.0011	±0.0012
1.7500	0.0049	±0.0014	±0.0016
1.7508	0.0057	±0.0017	±0.0018

FOR A SCREW OR BOLT READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM.
±0.0000	0.0000	1.7451
±0.0003	0.0011	1.7440
±0.0006	0.0021	1.7430
±0.0010	0.0031	1.7420
±0.0013	0.0041	1.7410
±0.0016	0.0051	1.7400
±0.0018	0.0057	1.7394

TABLE 17

2 INCH $4\frac{1}{2}$ THREADS U.S.S.

BASIC PITCH DIAMETER 1.8557

Outside and Root Measurements

	FOR A TAP OR NUT FLAT ON BOTTOM OF THREAD SAME AS 4 PITCH TOOL=0.0313		U.S.S BASIC SIZES	FOR A SCREW OR BOLT FLAT AT ROOT OF THREAD SAME AS 5 PITCH TOOL=0.0250	
	MIN.	MAX		MAX	MIN
OUTSIDE DIAMETER	2.0025	2.0199	2.0000	2.0000	1.9761
ROOT "	1.7158	1.7249	1.7113	1.7113	1.6984

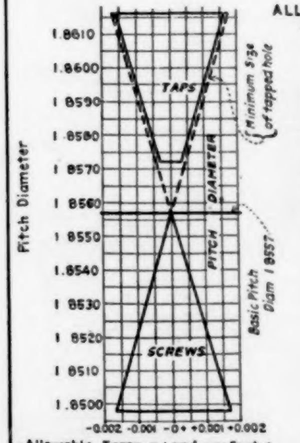
LIMITS ON PITCH DIAMETER AT PERFECT LEAD

TAP	TAPPED HOLE	CLEARANCE		SCREW OR BOLT
		TAP	HOLE	
MAX. 1.8616	MAX. 1.8616	0.0118	0.0118	1.8498 MIN.
MIN. 1.8572	MIN. 1.8557	0.0015	0.0000	1.8557 MAX.

Tolerance for Thread Angle ± 15 Minutes

CHART AND TABLE FOR TAPS, NUTS, SCREWS ETC. WITH LENGTH OF THREAD ENGAGEMENT, 0 TO 2 INCH (ONCE THE DIAM.)

NOTE: In practice these can be recommended for length of thread engagement to one and one half diam's (3") because of the partial rectifying of errors in lead by "flow of metal" see Pars. 24 and 25



ALLOWABLE ERROR IN LEAD PER INCH FOR ACTUAL PITCH DIAMETER

FOR A TAP OR TAPPED HOLE READ FROM LEFT TO RIGHT

ACTUAL PITCH DIAM	AMOUNT OVER BASIC	ALLOWABLE ERROR IN LEAD PER INCH	
		TAP	TAPPED HOLE
1.8572	0.0015	±0.0003	±0.0004
1.8580	0.0023	±0.0006	±0.0007
1.8590	0.0033	±0.0009	±0.0010
1.8600	0.0043	±0.0012	±0.0012
1.8610	0.0053	±0.0014	±0.0015
1.8616	0.0059	±0.0016	±0.0017

FOR A SCREW OR BOLT READ FROM RIGHT TO LEFT

ALLOWABLE ERROR IN LEAD PER INCH	AMOUNT UNDER BASIC	ACTUAL PITCH DIAM
±0.0000	0.0000	1.8557
±0.0002	0.0007	1.8550
±0.0005	0.0017	1.8540
±0.0008	0.0027	1.8530
±0.0010	0.0037	1.8520
±0.0014	0.0047	1.8510
±0.0017	0.0059	1.8498

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TABLE 18

FORMULÆ FOR MEDIUM-FIT SCREWS, NUTS, TAPS, ETC., SUITED FOR GENERAL USE

SYMBOLS USED IN FORMULÆ

Basic full or external diameter $= D$
Basic pitch diameter $= E$
Basic root diameter $= K$
Number of threads per inch $= n$
Normal lead $= L$

SCREWS

Max. external diam. $= D$
Max. pitch diam. $= E$
Max. root diam. $= K$

Min. external diam. $= D - \left(\frac{0.102}{n} + \frac{0.054}{n+40}\right)$

Min. pitch diam. $= E - (0.0045 \times \sqrt{D} - 0.0005)$

Min. root diam. $= K - \left(\frac{0.033}{n} + \frac{25}{n+40}\right)$

Max. error ($\pm$ normal) allowable in lead per inch. Length of engagement up to one diam. $= \frac{0.57735\,(0.0045 \times \sqrt{D} - 0.0005)}{D}$

(This formula also applies to tapped holes.)

TAPS AND TAPPED HOLES

Max. external diam. $= D + \frac{0.04}{n} + \frac{0.224}{n+40}$

Max. pitch diam. $= E + 0.0045 \times \sqrt{D} - 0.0005$

Max. root diam. $= K + \frac{0.033}{n} + \frac{0.25}{n+40}$

Min. external diam. $= D + \frac{0.112}{n+40}$

Min. pitch diam. $= E + \frac{0.0045 \times \sqrt{D} - 0.0005}{4}$

Min. root diam. $= K + \frac{0.02}{n}$

TAPS ONLY

Max. error ($\pm$ normal) allowable in lead =

$$\text{Max. error } (\pm \text{ normal}) \text{ allowable in lead of screw} - \frac{\left(\begin{array}{c}\text{Max. error } (\pm \text{ normal}) \\ \text{allowable in lead of screw}\end{array}\right)^2}{0.03}$$

APPLYING FORMULÆ AND TABLES FOR PITCHES OTHER THAN U. S. S.

The diagram, Fig. 4, illustrates the relation of the screw to the tapped hole, showing maximum and minimum allowances.

As the formulæ given above for external and root diameters are based on the number of threads per inch, the maximum and minimum limits are not changed by a change in diameter and the allowances given in the formulæ for the U. S. Standard diameter and pitch can be used.[1]

Example: 1 in. diameter, 20 threads to the inch. For external diameter for ¼ in. 20 it will be found from the formula (or by reference to Fig. 7) that the maximum for screws is basic while the minimum is 0.0060 under. The maximum for tap or nut is +0.0057 in., while the minimum is +0.0019 in., these allowances being always the same for 20 threads to the inch for any diameter. The allowances for pitch diameter and lead, however, are based on formulæ having the diameter as a factor.

Example: 1 in. diameter, 20 threads to the inch. It will be found by the formula (or by reference to Figs. 5 and 6) that the maximum pitch diameter of screw is basic. Minimum pitch diameter $= 1 - (0.0045 \times \sqrt{1} - 0.005) = 1 - 0.004 = 0.996$ min. pitch diam. of screw.

Maximum pitch diameter of tap $= 1 + 0.004 = 1.004$ in.

Minimum pitch diameter of tap $= 1 + (0.004/4) = 1.001$ in.

Maximum error ($\pm$ normal) allowable in lead of screws if the length of engagement = 1 diameter (in this example 1 in.) =

$$\frac{0.57735\ (0.0045 \times \sqrt{1} - 0.005)}{1} = 0.0023 \text{ max. error in lead.}$$

If, however, the length of engagement is only ½ in. instead of 1 in., a proportionately greater error in lead can be allowed.

$0.0023 \div \frac{1}{2} = 0.0046$ in. maximum error in lead for 1 in. 20 threads with ½ in. length of engagement.

Maximum error in lead for tap for 1 in. length of engagement

$$0.0023 - \frac{0.0023^2}{0.03} = 0.0017 \text{ max. error in lead.}$$

For ½ length of engagement, $0.0017 \div \frac{1}{2} = 0.0034$.

TO FIND POSITION OF A TAP OR SCREW IN THE CHART, FIG. 3

First, find its actual pitch or angular diameter as measured with a "V"-thread micrometer. Subtract from this diameter the basic pitch diameter as given in the table. The difference will be its deviation from basic pitch diameter. If plus, lay off its value to scale above the horizontal coördinate line; and if minus, below the horizontal line.

Second, find the "error in lead per inch" with a lead measuring instrument. If the lead is coarse, equal plus, lay off its value to scale to the right of the vertical coördinate line, or if fine, equal minus, lay it off to the left of the vertical line.

The point where these first and second values intersect is the position of the tap or screw on the chart. If it is within the shaded area, the tap or screw is within the prescribed limits, and if outside of the shaded area it is not up to the standard represented by the chart and table. Taps and nuts must fall within the shaded area above the horizontal line; while screws and bolts must fall within the shaded area below the horizontal line.

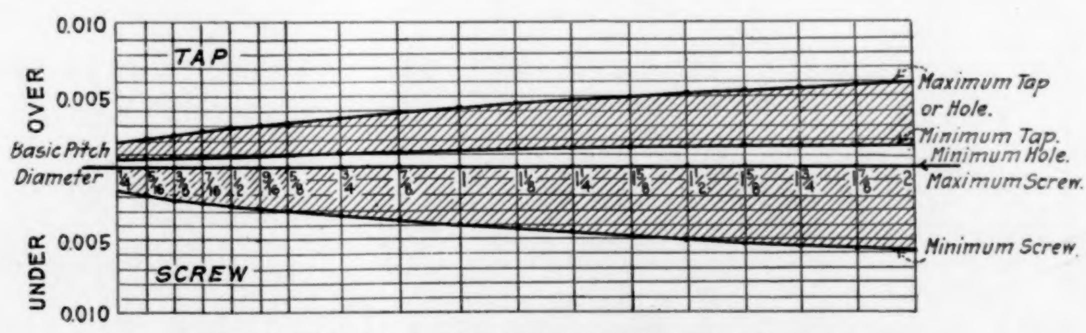

FIG. 5 MAXIMUM AND MINIMUM CLEARANCE, PITCH DIAMETER

Example for a Tap: Suppose a tap measured 0.001 in. over basic pitch diameter; this value would fall on the horizontal line *CK* (Fig. 3), and if its lead should be 0.0005 in. fine or minus in 1 in., this value would fall on the vertical dotted line passing through *K*, and the tap falls within the area of the chart.

Example for a Screw: Suppose a screw measured 0.0010 in. under basic pitch diameter, it would then fall on the horizontal line *AL* (Fig. 3), and if its lead were 0.0020 in. coarse or plus it would fall on the vertical dotted line passing through *L*, and the screw falls outside the area of the chart.

[1] These limits can also be obtained by reference to Figs. 7 and 8.

TABLE 19 MINIMUM AND MAXIMUM PITCH DIAMETERS OF TAPS AND SCREWS AT PERFECT LEAD FOR U. S. STD.

Medium Grade for General Work. All Dimensions in Inches

	TAP			SCREW	
Nom. diam. and threads per inch	Basic pitch diameters	Min. and max. add. to basic pitch diam.	Min. and max. pitch diam.	Max. and min. reduction from basic pitch diam.	Max. and min. pitch diam.
1/4—20	0.2175	0.0004 0.0018	0.2179 0.2193	0.0000 0.0018	0.2175 0.2158
5/16—18	0.2764	0.0005 0.0020	0.2769 0.2784	0.0000 0.0020	0.2764 0.2744
3/8—16	0.3344	0.0006 0.0023	0.3350 0.3367	0.0000 0.0023	0.3344 0.3321
7/16—14	0.3911	0.0006 0.0025	0.3917 0.3936	0.0000 0.0025	0.3911 0.3886
1/2—13	0.4501	0.0007 0.0027	0.4508 0.4528	0.0000 0.0027	0.4501 0.4474
9/16—12	0.5084	0.0007 0.0029	0.5091 0.5113	0.0000 0.0029	0.5084 0.5055
5/8—11	0.5660	0.0008 0.0031	0.5668 0.5691	0.0000 0.0031	0.5660 0.5629
3/4—10	0.6851	0.0009 0.0034	0.6860 0.6885	0.0000 0.0034	0.6851 0.6817
7/8—9	0.8029	0.0009 0.0037	0.8038 0.8066	0.0000 0.0037	0.8029 0.7992
1—8	0.9188	0.0010 0.0040	0.9198 0.9228	0.0000 0.0040	0.9188 0.9148
1 1/8—7	1.0322	0.0011 0.0043	1.0333 1.0365	0.0000 0.0043	1.0322 1.0279
1 1/4—7	1.1572	0.0011 0.0045	1.1583 1.1617	0.0000 0.0045	1.1572 1.1527
1 3/8—6	1.2668	0.0012 0.0048	1.2680 1.2716	0.0000 0.0048	1.2668 1.2620
1 1/2—6	1.3918	0.0013 0.0050	1.3931 1.3968	0.0000 0.0050	1.3918 1.3868
1 5/8—5 1/2	1.5069	0.0013 0.0052	1.5082 1.5121	0.0000 0.0052	1.5069 1.5017
1 3/4—5	1.6201	0.0014 0.0055	1.6215 1.6256	0.0000 0.0055	1.6201 1.6147
1 7/8—5	1.7451	0.0014 0.0057	1.7465 1.7508	0.0000 0.0057	1.7451 1.7394
2—4 1/2	1.8557	0.0015 0.0059	1.8572 1.8616	0.0000 0.0059	1.8557 1.8498

TABLE 20 OUTSIDE AND ROOT DIAMETERS FOR TAPS AND SCREWS — U. S. S.T.D.

Medium Grade for General Work. All Dimensions in Inches

TAP OR NUT								SCREW			
Outside Diam.				Root Diam.							
1	2	3	4	5	6	7	8	9	10	11	12
Nominal diam. and threads per inch	Decimal basic outside diam.	Addition to basic O. D.	Min. and max. O. D.	U. S. S. root diam.	Pitch of tool for tap and width across point	New basic root diam.	Min. and max. root diam.	Max. and min. outside diam.	Pitch of tool for thread and width across point	New basic root diam.	Max. and min. root diam.
1/4—20	0.2500	0.0019 0.0057	0.2519 0.2557	0.1850	18 0.0069	0.1863	0.1860 0.1908	0.2500 0.2440	22 0.0057	0.1841	0.1850 0.1792
5/16—18	0.3125	0.0019 0.0061	0.3144 0.3186	0.2403	16 0.0078	0.2418	0.2414 0.2464	0.3125 0.3059	20 0.0062	0.2391	0.2403 0.2342
3/8—16	0.3750	0.0020 0.0065	0.3770 0.3815	0.2936	14 0.0089	0.2955	0.2949 0.3001	0.3750 0.3677	18 0.0069	0.2921	0.2936 0.2871
7/16—14	0.4375	0.0021 0.0070	0.4396 0.4445	0.3447	13 0.0096	0.3459	0.3461 0.3517	0.4375 0.4292	16 0.0078	0.3428	0.3447 0.3377
1/2—13	0.5000	0.0021 0.0073	0.5021 0.5073	0.4001	12 0.0104	0.4015	0.4016 0.4074	0.5000 0.4911	14 0.0089	0.3989	0.4001 0.3928
9/16—12	0.5625	0.0022 0.0076	0.5647 0.5701	0.4542	11 0.0114	0.4559	0.4559 0.4618	0.5625 0.5530	13 0.0096	0.4528	0.4542 0.4466
5/8—11	0.6250	0.0022 0.0080	0.6272 0.6330	0.5069	10 0.0125	0.5089	0.5087 0.5148	0.6250 0.6147	12 0.0104	0.5053	0.5069 0.4990
3/4—10	0.7500	0.0022 0.0085	0.7522 0.7585	0.6201	9 0.0139	0.6225	0.6221 0.6284	0.7500 0.7387	11 0.0114	0.6181	0.6201 0.6118
7/8—9	0.8750	0.0023 0.0090	0.8773 0.8840	0.7307	8 0.0156	0.7337	0.7329 0.7395	0.8750 0.8626	10 0.0125	0.7283	0.7307 0.7219
1—8	1.0000	0.0023 0.0092	1.0023 1.0092	0.8376	7 0.0179	0.8416	0.8401 0.8469	1.0000 0.9861	9 0.0139	0.8346	0.8376 0.8283
1 1/8—7	1.1250	0.0024 0.0105	1.1274 1.1355	0.9394	6 0.0208	0.9444	0.9423 0.9494	1.1250 1.1093	8 0.0156	0.9356	0.9394 0.9294
1 1/4—7	1.2500	0.0024 0.0105	1.2524 1.2605	1.0644	6 0.0208	1.0696	1.0673 1.0744	1.2500 1.2343	8 0.0156	1.0606	1.0644 1.0544
1 3/8—6	1.3750	0.0024 0.0115	1.3774 1.3865	1.1585	5 1/2 0.0227	1.1618	1.1618 1.1694	1.3750 1.3568	7 0.0179	1.1533	1.1585 1.1476
1 1/2—6	1.5000	0.0024 0.0115	1.5024 1.5115	1.2835	5 1/2 0.0227	1.2868	1.2868 1.2944	1.5000 1.4818	7 0.0179	1.2783	1.2835 1.2726
1 5/8—5 1/2	1.6250	0.0025 0.0122	1.6275 1.6372	1.3888	5 0.0250	1.3928	1.3925 1.4003	1.6250 1.6053	6 0.0208	1.3855	1.3888 1.3773
1 3/4—5	1.7500	0.0025 0.0130	1.7525 1.7630	1.4902	4 1/2 0.0278	1.4950	1.4942 1.5024	1.7500 1.7284	5 1/2 0.0227	1.4863	1.4902 1.4780
1 7/8—5	1.8750	0.0025 0.0130	1.8775 1.8880	1.6152	4 1/2 0.0278	1.6200	1.6192 1.6274	1.8750 1.8534	5 1/2 0.0227	1.6113	1.6152 1.6030
2—4 1/2	2.0000	0.0025 0.0139	2.0025 2.013	1.7113	4 0.0313	1.7173	1.7158 1.7243	2.0000 1.9761	5 0.0250	1.7065	1.7113 1.6984

TABLE 21 INSPECTION LIMITS FOR U. S. S. TAPS

ALL DIMENSIONS IN INCHES

1/4-IN. 20 U. S. S. BASIC PITCH DIAM. 0.2175		5/16-IN. 18 U. S. S. BASIC PITCH DIAM. 0.2764		3/8-IN. 16 U. S. S. BASIC PITCH DIAM. 0.3344		1/2-IN. 13 U. S. S. BASIC PITCH DIAM. 0.4301	
Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.
0.2179	±0.0005	0.2769	±0.0005	0.3350	±0.0005	0.4508	±0.0006
0.2185	±0.0018	0.2775	±0.0016	0.3355	±0.0013	0.4515	±0.0013
0.2190	±0.0029	0.2780	±0.0025	0.3360	±0.0020	0.4520	±0.0019
0.2193	±0.0035	0.2784	±0.0033	0.3365	±0.0028	0.4525	±0.0025
				0.3367	±0.0031	0.4528	±0.0028

5/8-IN. 11 U. S. S. BASIC PITCH DIAM. 0.5660		3/4-IN. 10 U. S. S. BASIC PITCH DIAM. 0.6851		7/8-IN. 9 U. S. S. BASIC PITCH DIAM. 0.8029		1-IN. 8 U. S. S. BASIC PITCH DIAM. 0.9188	
Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.
0.5668	±0.0006	0.6860	±0.0005	0.8038	±0.0004	0.9198	±0.0004
0.5675	±0.0012	0.6865	±0.0009	0.8045	±0.0009	0.9205	±0.0008
0.5680	±0.0016	0.6870	±0.0012	0.8050	±0.0012	0.9210	±0.0011
0.5685	±0.0021	0.6875	±0.0016	0.8055	±0.0016	0.9215	±0.0014
0.5690	±0.0026	0.6880	±0.0020	0.8060	±0.0019	0.9220	±0.0017
		0.6885	±0.0024	0.8066	±0.0023	0.9225	±0.0019
						0.9228	±0.0021

1 1/4-IN. 7 U. S. S. BASIC PITCH DIAM. 1.1572		1 1/2-IN. 6 U. S. S. BASIC PITCH DIAM. 1.3918		1 3/4-IN. 5 U. S. S. BASIC PITCH DIAM. 1.6201		2-IN. 4 1/2 U. S. S. BASIC PITCH DIAM. 1.8557	
Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.
1.1583	±0.0003	1.3930	±0.0004	1.6215	±0.0004	1.8572	±0.0004
1.1590	±0.0006	1.3940	±0.0008	1.6225	±0.0007	1.8580	±0.0006
1.1595	±0.0009	1.3950	±0.0011	1.6235	±0.0010	1.8590	±0.0009
1.1600	±0.0011	1.3960	±0.0015	1.6245	±0.0014	1.8600	±0.0012
1.1605	±0.0013	1.3965	±0.0017	1.6255	±0.0017	1.8610	±0.0014
1.1610	±0.0016	1.3968	±0.0018			1.8615	±0.0016
1.1617	±0.0019						

TABLE 22 INSPECTION LIMITS FOR U. S. S. SCREWS

ALL DIMENSIONS IN INCHES

1/4-IN. 20 U. S. S. BASIC PITCH DIAM. 0.2175		5/16-IN. 18 U. S. S. BASIC PITCH DIAM. 0.2764		3/8-IN. 16 U. S. S. BASIC PITCH DIAM. 0.3344		1/2-IN. 13 U. S. S. BASIC PITCH DIAM. 0.4501	
Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.
0.2170	±0.0012	0.2760	±0.0008	0.3340	±0.0006	0.4495	±0.0007
0.2165	±0.0022	0.2755	±0.0017	0.3335	±0.0014	0.4490	±0.0013
0.2160	±0.0033	0.2750	±0.0027	0.3330	±0.0021	0.4485	±0.0018
0.2157	±0.0040	0.2745	±0.0037	0.3325	±0.0029	0.4480	±0.0024
				0.3321	±0.0035	0.4474	±0.0031

5/8-IN. 11 U. S. S. BASIC PITCH DIAM. 0.5660		3/4-IN. 10 U. S. S. BASIC PITCH DIAM. 0.6851		7/8-IN. 9 U. S. S. BASIC PITCH DIAM. 0.8029		1-IN. 8 U. S. S. BASIC PITCH DIAM. 0.9188	
Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.
0.5655	±0.0005	0.6845	±0.0005	0.8025	±0.0003	0.9185	±0.0002
0.5650	±0.0009	0.6840	±0.0009	0.8020	±0.0006	0.9180	±0.0005
0.5645	±0.0014	0.6835	±0.0012	0.8015	±0.0009	0.9175	±0.0008
0.5640	±0.0018	0.6830	±0.0016	0.8010	±0.0013	0.9170	±0.0010
0.5635	±0.0023	0.6825	±0.0020	0.8005	±0.0016	0.9165	±0.0013
0.5629	±0.0028	0.6820	±0.0024	0.8000	±0.0020	0.9160	±0.0016
		0.6817	±0.0026	0.7992	±0.0025	0.9155	±0.0019
						0.9148	±0.0023

1 1/4-IN. 7 U. S. S. BASIC PITCH DIAM. 1.1572		1 1/2-IN. 6 U. S. S. BASIC PITCH DIAM. 1.3918		1 3/4-IN. 5 U. S. S. BASIC PITCH DIAM. 1.6201		2-IN. 4 1/2 U. S. S. BASIC PITCH DIAM. 1.8557	
Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.	Actual pitch diam.	Allowable error in lead per in.
1.1565	±0.0003	1.3910	±0.0003	1.6195	±0.0002	1.8550	±0.0002
1.1560	±0.0006	1.3900	±0.0007	1.6190	±0.0004	1.8540	±0.0005
1.1550	±0.0010	1.3890	±0.0011	1.6180	±0.0007	1.8530	±0.0008
1.1540	±0.0015	1.3880	±0.0015	1.6170	±0.0010	1.8520	±0.0011
1.1530	±0.0020	1.3870	±0.0018	1.6160	±0.0014	1.8510	±0.0014
1.1527	±0.0021	1.3868	±0.0019	1.6150	±0.0017	1.8498	±0.0017
				1.6147	±0.0018		

Gaging Devices

In order to ascertain whether the work comes within the required limits as represented by the triangular zones of the tables, it is desirable to measure simultaneously both the pitch diameter and the lead.

Among the tools suggested for accomplishing this purpose are the following: In Fig. 9 is shown a gage which is adjustable for a range of diameters, the micrometer thimble being used to obtain the readings for the diameter. An adjustable block supports the work so that it will be held parallel to the center line and can be set to be measured on the center line. The grooved roll fits over the thread and is free sideways to allow for variations in lead. This roll is set to the standard pitch diameter of the work and is adjusted by the micrometer thimble. The floating point is so connected that the longer lever shows the variation in lead and the shorter lever variations in pitch diameter, each pivoting about its own center. The work is placed between the points as shown by the dotted section, and the variations from standard or pitch diameter and lead are read directly in thousandths of an inch.

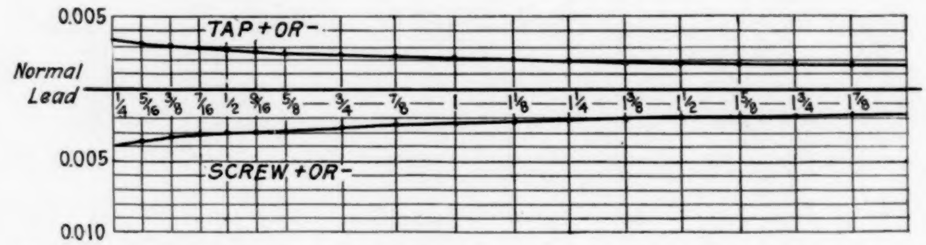

Fig. 6 Allowable Variation in Lead Over or Under Normal for Maximum Error in Diameter

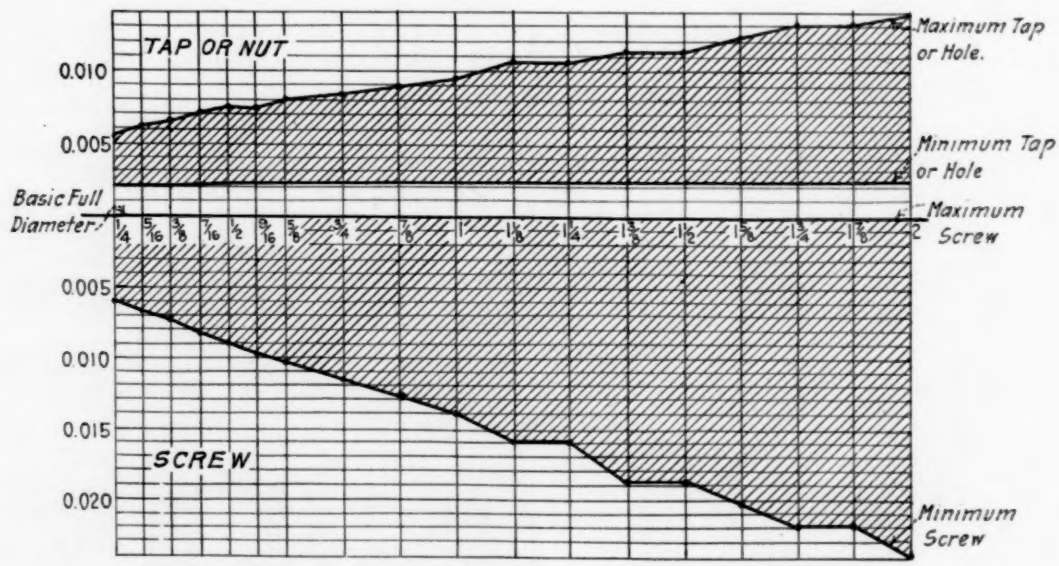

Fig. 7 Maximum and Minimum Clearance, Full or External Diameter

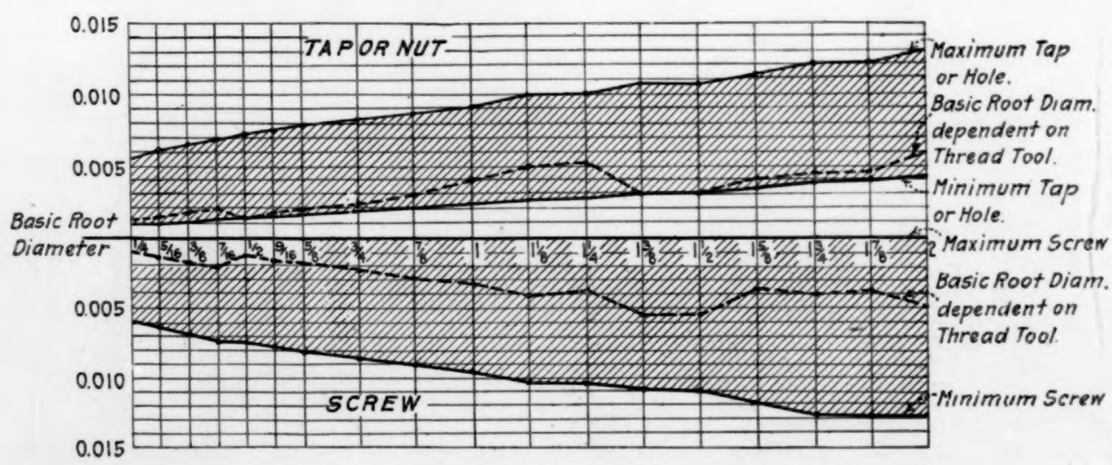

Fig. 8 Maximum and Minimum Clearance, Root Diameter

In Fig. 10 is a combination gage for diameter and lead. Point A is adjustable longitudinally by means of a micrometer screw so that it can be placed in proper relation to B, which is adjustable for different diameters, the pitch diameter of work

being read directly by means of its micrometer. The point *C* is connected to the indicator, variations being read directly on the scale in thousandths of an inch. A block supports the work in proper relation to the gage points, and is set by means of the micrometer *D*.

A combination gage for pitch diameter and lead, having a fixed point and two adjustable points, is shown in Fig. 11. The variations in both cases are read on the dial indicators in thousandths of an inch. Indicators must be set to a standard before testing the work. An adjustable block may be set by a vernier or micrometer so that work resting on it will have its center line in line with the gage points.

In Figs. 12 and 13 is shown the type of gages now generally in use for measuring screw threads. Gages of this type do not determine the combined error of lead and diameter, but are satisfactory for many classes of work. If the thickness or length of gage is made to correspond with the length of fit between the screw and nut or tapped hole, work which will pass inspection by the gages will interchange in use, and thus the desired result will be attained.

Where expensive special tools are not available good results can be obtained by measuring the diameter with an ordinary *screw-thread micrometer* shown in Fig. 14, and the lead, with the *lead-measuring indicator,* shown in Fig. 15. By the combined use of gages shown in Figs. 14 and 15, it can readily be determined whether the work will come within the triangular zones on the tables, and thus pass inspection.

Another lead-measuring instrument is shown in Fig. 16. This uses a commercial test indicator for noting the variations from correct lead.

Fig. 17 shows a simple gage which might be provided at small expense where a block of a thickness of about one or one and one-half diameters is tapped at one end for approximately standard pitch diameter and correct lead, while the other end is made thin and tapped under standard pitch diameter so as to be used as a minimum-diameter gage. A screw which will pass through the standard or thicker gage but will not pass through the thin gage may be presumed to be within

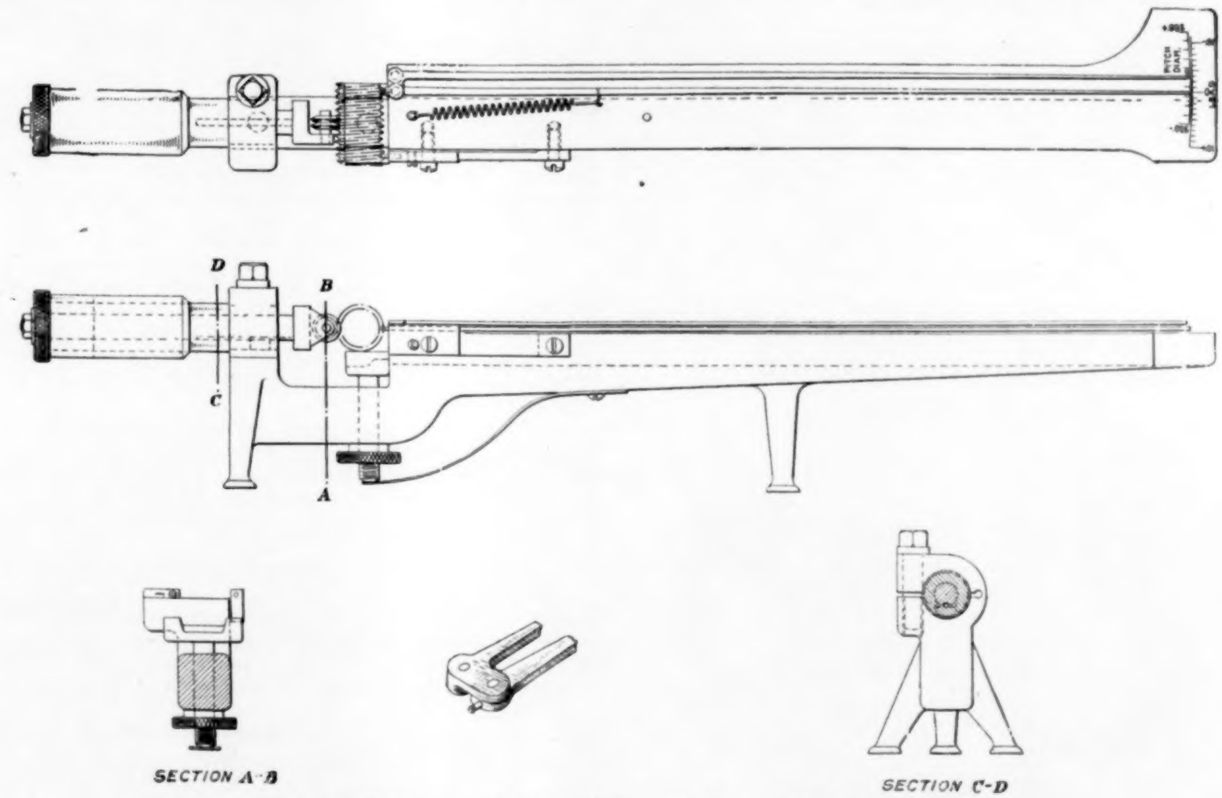

Fig. 9 Combined Lead- and Diameter-Measuring Gage, with Compound Levers

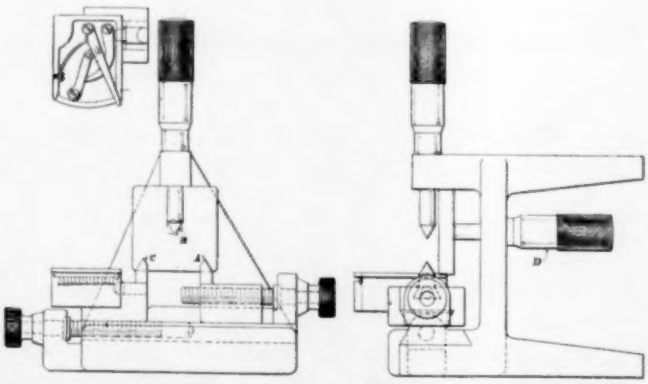

Fig. 10 Combined Lead- and Diameter-Measuring Gage, with Micrometer and Lever Indicator Readings

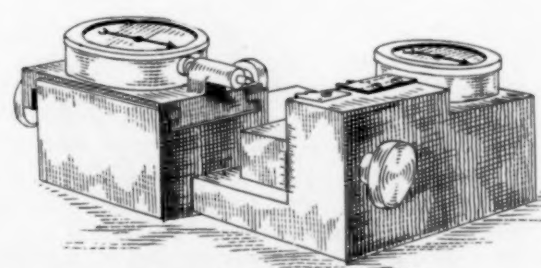

Fig. 11 Gage with Dial Indicator Readings

the required limits of tolerances for variation in both lead and pitch diameter.

Many other designs of measuring instruments have been submitted to the committee, having points of excellence, but

Fig. 12 Plug Gage

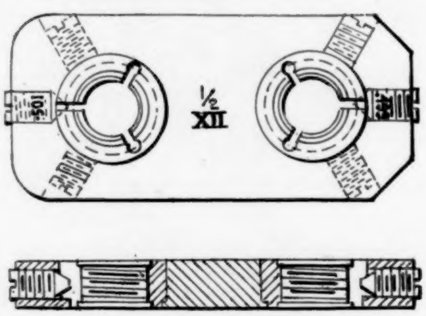

Fig. 13 Ring Gage

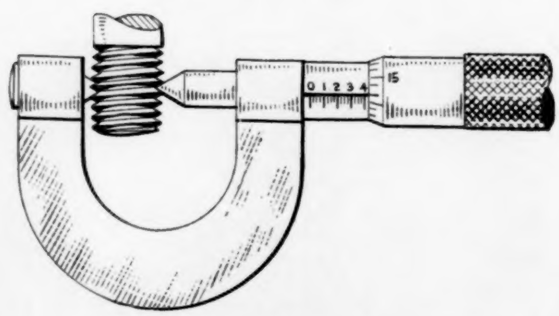

Fig. 14 Screw-Thread Micrometer

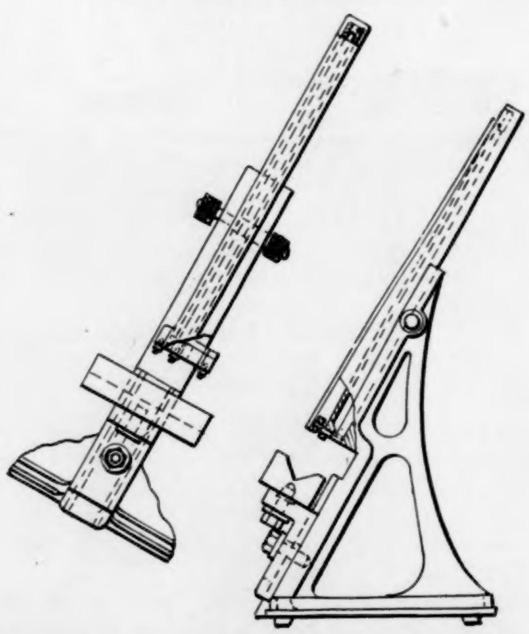

Fig. 15 Lead-Measuring Gage

it has been thought best here to show simply typical and suggestive designs which can be developed in detail to suit particular needs.

Tables 19 and 20 give minimum and maximum diameters for U. S. S. taps, nuts and screws; while Tables 21 and 22 give inspection limits for taps and screws, with the varying allowance in lead for different diameters within the limits specified.

Definitions and Symbols

The letter symbols given below are those recommended by the U. S. Bureau of Standards:

Allowance. Variation in dimensions to allow for different qualities of fit.

Angle Diameter. Same as pitch or effective diameter.

Angle of Thread, "*A*." The total or included angle between the sides or slopes of a thread, in a plane passing through the axis of the screw or nut.

Clearance. The space between a screw and a threaded hole.

Clearance Angle. Allowance on the angles or slopes of the thread for screw threads to fit together.

Clearance, Bottom. Allowance or space at bottom of a thread to prevent a bearing at this point and to provide space for dirt.

Clearance, Outside. Allowance between outside diameter of screw and bottom of tapped hole.

Core Diameter, "*K*." English term for the root or bottom diameter of a screw and the small diameter of a nut. In the case of the nut it is measured between the crests of the thread. See Root Diameter.

Crest. English term for the top or most prominent part of a thread, whether on the screw or in the nut.

Effective Diameter, "*E*." English term for pitch diameter and defined as the length of a line drawn through the axis and at right angles to it, measured between the points where the line cuts the slopes of the thread.

External Diameter, "*D*." Same as full diameter or outside diameter.

Finger Fit. Where the screw fits the tapped hole so as to just be screwed in with the fingers.

Flow of Thread. The movement of metal in a screw or nut, or both, when screwed together by force, to fit in spite of an error in lead.

Flute. The groove cut in taps and reamers to form cutting edges and to allow room for chips.

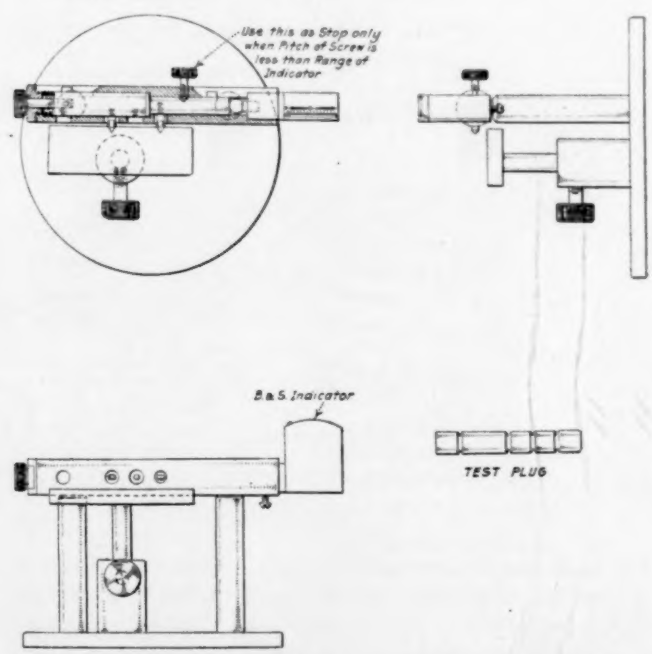

Fig. 16 Lead-Measuring Gage with Indicator Reading

Franklin Institute Thread. The *form* of thread adopted by The Franklin Institute in 1864. It is a 60-deg. angle thread with ⅛ of the vertical height cut from the top and filled in at the bottom. It is not confined to any special series of pitches.

Full Diameter, "*D*." English term for outside diameter.

Gage, Check or Checking. Gage for checking or testing other gages.

Gage, Limit. A gage for insuring that any given dimension is within the tolerance laid down for the class of work to be produced.

Gage, Master. A gage which is kept as a standard, solely for comparing reference gages.

Gage, Reference. A gage used by the manufacturer and by which the workman's gage is tested. A copy of the Master Gage.

Gage, Shop or Workman's. A gage used by the workman in everyday practice. It is tested by or with the Reference Gage.

Gage, Standard. English term for Master Gage.

Land. The space between flutes on a tap or reamer. It includes the cutting edge and the supporting metal behind it.

Lead, "L." The distance a screw advances in one turn. In a single-thread screw this is the same as pitch.

Lead, Normal, "L." Correct lead.

Lead per Inch. The lead multiplied by its reciprocal. For a perfect thread this equals one inch.

Limits. Two sizes expressed by positive dimensions, the larger being termed the maximum, and the smaller the minimum, limit.

Limit Gage. See Gage, Limit.

Outside Diameter, "D." Diameter on the outside of the thread. External or full diameter.

Pitch. The distance from a given point on one thread to a similar point on the next thread, along the axis of the screw. The same as lead for a single thread. The reciprocal of threads per inch.

Pitch Diameter, "E." Same as effective diameter. Also defined as the diameter of a screw at a point midway of the depth of the thread. Equal to the outside diameter less the depth of one thread. This depth equals:

$$\text{For "V"-threads} = \frac{0.866}{\text{Thds. per inch}} \quad \text{For U. S. S.} = \frac{0.6495}{\text{Thds. per inch}}$$

Relief. The reduced diameter behind the cutting edge of a tap.

Root. Bottom or smallest diameter of thread, whether in screw or nut.

Root Diameter, "K." The smallest diameter, whether for a screw or in a nut.

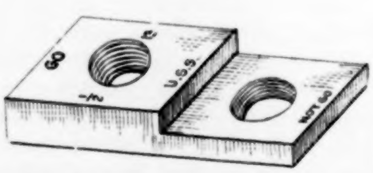

Fig. 17 Cheap Gage for Temporary Use

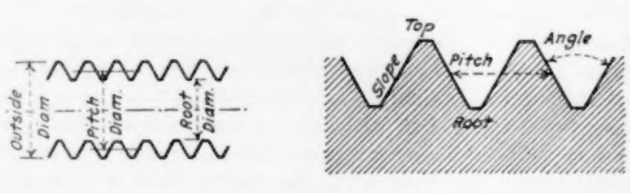

Fig. 18 Diagrams Showing Elements of Thread

Slope of Thread. The angular part which connects the large and small diameters of a thread.

Standard Gage. English term for Master Gage. (See Gage, Master.)

Thread, Modified "V." A form of thread having a 60-deg. angle and such that if carried to a sharp point it would measure to the nominal size, but with the top or bottom, or both, modified usually by being flattened according to conditions or individual ideas.

Thread, U. S. S. The standard adopted by the United States Government, which uses the Franklin Institute form of thread with a definite pitch for each diameter. (See Franklin Institute Thread.)

Thread, "V." A form of thread having a 60-deg. angle and sharp at top and bottom. Impossible in practice and always more or less modified, whether intentionally or not.

Thread, Whitworth. A thread having a 55-deg. angle and a rounded top and bottom. The proportions are:

$$\text{Depth} = \frac{0.640327}{\text{Thds. per in.}}. \quad \text{Radius of top and bottom} = \frac{0.137329}{\text{Thds. per in.}}$$

Thread Micrometer. A micrometer caliper with special points for measuring the pitch or angle diameter of the screw.

Threads per Inch, "n." Number of threads in one inch of length.

Tolerance. The allowable variation in size, equal to the difference between the minimum and maximum limits.

Turns per Inch, "N." The number of turns required to advance one inch. Equal to the threads per inch of a single-threaded screw.

Wrench Fit. Where the screw fits the tapped hole so tightly as to require a wrench to screw into place. Used for cylinder studs in steam engines and for similar work.

Respectfully submitted,

Luther D. Burlingame, *Chairman*
Ellwood Burdsall
Frederic G. Coburn
Fred H. Colvin
A. A. Fuller
James Hartness
Will R. Porter
Frank O. Wells
Walter F. Worthington
Charles D. Young

Committee on Tolerances in Screw Thread Fits

Errata

Table 7, second line of "Note": For $\frac{5}{16}$" read $\frac{15}{16}$".

Table 9, Limits on Pitch Diameter at Perfect Lead: Under "Screw or Bolt" read 0.7992 min. instead of 0.8012 min.

Table 18, Allowable Error in Lead per Inch for Actual Pitch Diameter: Under column headed "Tapped Hole" read ± 0.0013 instead of ± 0.0012.

The Food Administration has recently issued a message urging conservation of ammonia. During 1918, it is stated, the Government should have for munitions alone 20,000,000 lb. of ammonia more than it is possible to make by working all the plants producing ammonia in this country to their maximum capacity.

This shortage will be greatly increased by the ammonia that will be furnished ice-making and refrigerating plants, but it is hoped that by appealing to the patriotism and business sense of all ammonia users and urging them to stop all waste and leakage, the usual consumption may be curtailed to such an extent as will permit at least the most efficient plants to run; particularly where natural ice is not available.

The returns lately received show that much ammonia loss is avoidable. Many plants use less than one-twentieth of a pound per ton of ice made; while others use from one-half to one pound per ton. The same inexcusable waste is found in many refrigerating plants. The only reason that can be given for permitting the enormous waste and expense to continue at some plants is that the management has not informed itself as to what is a reasonable consumption and the operating force is indifferent about leaks that might easily be stopped but are allowed to continue.

A saving of 25 per cent in the ammonia consumption of ice and refrigerating plants would mean several million pounds annually for munitions. Each pound will make twenty hand grenades. Late returns show this saving can be accomplished if all will stop the leaks.

The Ford Administration has also given out figures showing that in one ton of garbage there is sufficient glycerin to make the explosive charge for fourteen 75-mm. shells, enough "fatty acid" to manufacture 75 lb. of soap, fertilizer elements to grow 8 bu. of wheat, and a score of other valuable materials essential in munitions manufacture.

DISCUSSION OF SPRING MEETING PAPERS

ONE of the papers presented at the second General Session of the Spring Meeting at Worcester which, by reason of the keen interest now taken in matters relating to the subject of flight and the novel ideas advanced by the author, drew forth much illuminating discussion, was that by Prof. Morgan Brooks, on Air Propulsion.

In this paper, an extended abstract of which was printed in THE JOURNAL for May (p. 390), the author describes experiments with propellers showing that the accepted screw theory of air propulsion does not accord with the facts. In these experiments air was impelled by a propeller at a speed approaching twice the screw advance for small blade angles, hence the theory of reflection or batting action should replace the screw theory. Thrust is shown to be due in greater degree to velocity and less to blade disk area than is commonly supposed.

In presenting the paper Professor Brooks said that although the facts stated seemed impossible to many, their essential accuracy could be absolutely depended upon. The substitute reflection theory advanced he offered without claims as to its correctness, but as a suggestion open to criticism and alteration.

Those contributing to the discussion were N. W. Akimoff, C. W. Howell, G. De Bothezat, Dr. S. W. Stratton, L. R. Gulley, J. C. Hunsaker, M. B. Sellers, Lieut.-Col. J. S. Vincent, W. C. Durfee and H. F. Hagen, whose remarks immediately follow.

AIR PROPULSION

DISCUSSION OF PAPER BY PROF. MORGAN BROOKS

N. W. AKIMOFF (written). Professor Brooks' paper will be welcomed by the profession only in so far as it represents a sincere opinion, purely subjective, of that capable engineer. In itself the paper is open to grave objections. The theory proposed apparently contemplates an infinite space of 30 in. vacuum, in which floats one particle of air, how large is so far unknown. The propeller blade runs into it and, in turn, experiences a little reaction, although the particle feels it much more than the blade itself. Splendid! but what becomes of the hydrodynamics of this delicate problem? All propeller theories that are based on supposing that the air is a material aggregation of separate particles are absolutely worthless: the screws built according to such theories are as likely to give 84 per cent as 48 per cent, because the very foundation is shaky.

The least unsatisfactory theory of propellers is that which takes into consideration the vortex theory of sustentation. Lanchester claims priority to the idea, although many other scientists of not quite so great repute also claim to have discovered it first. (See A Review of Hydrodynamical Theory, etc., by J. S. Hunsaker, International Engineering Congress, San Francisco, September 1915.)

He who looks into the vortex theory of sustentation will at once abandon theories about air particles as related to pitch or slip. Here the lift is made dependent upon a certain section constant, called circulation, and is equal to density times circulation times velocity *ad infinitum*.

The propeller blade can also be considered as a set of regular wing sections, say, RAF-6, or whatever they are, for which the "circulation" is either known or can be calculated. This has been done with satisfactory results; the trouble is that all such methods require a little knowledge, which certainly is most unfortunate; what we would like to have is a pocket book, or a table of some sort, but it does not work that way. Highly delicate is the confounded science of hydrodynamics!

Fig. 3 of Mr. Brooks' paper looks unusual; it has very likely been drawn by inference and not as a result of calculations.

The subject of static tests as a basis for judging of what the dynamic pull will be, is one of extreme difficulty, and here again the vortex theory is the only hope.

For the estimation of what the static pull will be within, say, 15 per cent or so, the writer has recently proposed the following crude formula: Static pull in lb. $= n^2D^4/2750$. (*Aviation*, 1917.) This appears to serve the purpose, but only within the prescribed limits; to estimate the pull of a screw is about the same as to build a helicopter screw—a difficult problem.

CHARLES W. HOWELL[1] (written). Recognition must be accorded the superspeed or acceleration theory so ably set forth by Professor Brooks, if it is desired to clear away the misconception existing as to the result of the application of power to a rotating element having angularly disposed surfaces to produce useful work in such a light and elastic medium as air, and if it is also desired to reduce the proposition to an exact status so that better working formulæ may be had.

Superspeed, as Professor Brooks states, is not readily observed in a static test of a two-blade propeller, but conversely may be directly observed in translational or flying tests of conventional airplanes, which have frequently been observed to fly a greater distance in unit time than the revolutions-times-pitch design of their propellers should fly them. Were this phenomenon confined to airplanes flying *with* the wind, we might assume, with reason, that it was merely the product of pitch minus slip, plus the velocity of the wind, but as the phenomenon may be observed to occur in substantially inert air and to a lesser degree in flying *against* moderate wind, it can only be explained in terms of velocity and impact—i. e., superspeed.

The air structure shown in Fig. 3 is quite characteristic of those produced under static tests by propellers of screw-pitch design. It has been observed, however, to vary radically under flying conditions, a beautifully clear example being shown by a screw-pitch propeller driven by a Gnome motor. This is a rotating-cylinder motor lubricated by castor oil, which frequently causes black smoke to be emitted from the exhaust ports. This smoke does not take the form of a rotating, contracting swirl, but forms into two ribbons or pennants which do not rotate but appear to change position with variation of motor speed.

It has also been noted that propellers differing from the conventional screw-pitch design will set up various forms of air structures. One has been observed to create a column substantially parallel and with small tendency to rotate. This would appear to approach the ideal condition, as it indicates a reduction of interference losses; that is, maximum acceleration or superspeed has occurred.

Experimental research with small model propellers appears to indicate that the air structure formed is influenced largely by the design of the rear or leaving edge of the propeller blade and may have a strong bearing on its efficiency, because the smaller the interference with or the mixing of the super-

[1] Vice-President, Aeronautical Society of America.

speeded air particles, the more parallel will be the lines of force and the greater the efficiency.

May I venture to suggest the term "acceleration" as more indicative of the physical result, and to express the opinion that the problem can be reduced to a precise condition and understanding by throwing out all considerations of screw and pitch and considering velocities and impact only?

G. De Bothezat (written).[1] The following may serve as a basis for a discussion of the flow of a fluid along a section of a propeller blade. Let it be assumed that we know exactly the direction along which the flowing fluid reaches a section of the blade (this theory determines exactly this direction). The following phenomena have then to be considered: If the flow reaches the blade section with a velocity W_1, it leaves it with a velocity W_2 (Fig. 1), which differs from W_1 in magnitude (slightly) and in direction.

At the points of contact of the fluid with the blade section there take place several quite complex phenomena of shocks and eddy formations. If the angle at which W_1 strikes the section of the blade is sufficiently small, then in the first approximation and using the terminology adopted in Professor Brooks' paper, W_1 is reflected on to the plane *pp* (Fig. 2) normal to the *resultant of pressure R* exerted by the flowing fluid on the section of the blade under consideration. As a rule, this plane *pp* is not parallel to the chord *cc* of the section, but for small angles of attack (but not extremely small) the angle between *cc* and *pp* is not large. This applies only to small angles of incidence between W_1 and the section under consideration, and is correct only in the first approximation, though sufficiently correct for practical purposes.

I have arrived at this conclusion from a study of the phenomena of flow, and this is only an attempt to indicate more precisely the direction of the plane of reflection experimentally discovered by Professor Brooks. But there is more to it. As the incidence of W_1 with respect to the section increases, then, from a certain moment on, the flow of the fluid in the rear of the section ceases to be permanent, and eddies are formed to the rear of the section (Fig. 3). This fact is beyond all doubt, and is confirmed by numerous experimental investigations, as, for example, those carried out at Teddington. In such a case it is more difficult to speak of the direction of the reflected air current, and it becomes necessary to introduce the conception of a current equivalent to the complex system of flow.

It can easily be seen how really complex is this problem, but the method which I use in my theory enables me to take into account all the phases of the phenomena of flow without having to resort to any simplifying assumptions. However, before I can explain how I attained this result, I have one more remark to make.

Let us consider a section of the blade which the air current strikes successively in the directions W_1, W_2, W_3 and W_0 (Fig. 4). The first resultants of the fluid pressure will be respectively R_1, R_2, R_3 and R_0, which means that as the incidence of W with respect to the section of the blade decreases, the resistance of R comes, so to speak, to lie in the section, and finally a moment arrives when W and R have the same direction. At that moment R has no component in a direction normal to W. I call *zero plane* (*zero* straight *line* on the section) the plane containing R_0 and W_0 when the component of R normal to W is zero. This zero line is located as indicated in the figure for nearly all sections of a propeller blade, and the angle which the zero line makes with chord *cc* (Fig. 5) depends on the profile of the section and may reach values in excess of 10 deg. For the majority of sections which I have examined this angle is comprised between 3 deg. and 12 deg.

When it is desired to compare a section of the blade to a thin ideal plane (geometric), it is of the utmost importance that the start should be made from the zero line and that all the characteristics of the section should be referred to it. Thus, the incidence or angles of attack should be measured only from this zero plane. Likewise the pitch of the sections should be measured from the zero line and not from the chord.

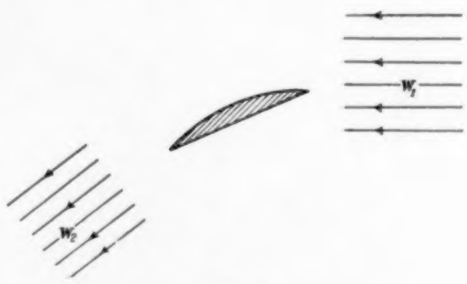

Fig. 1

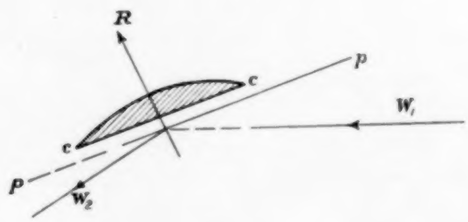

Fig. 2

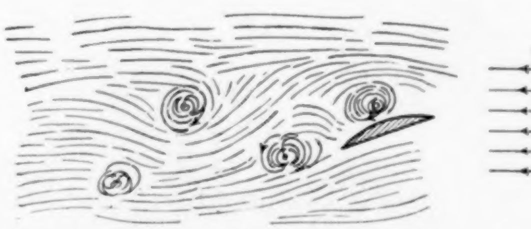

Fig. 3

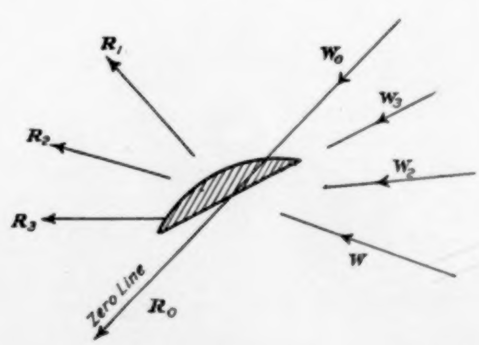

Fig. 4

The greater part of all misunderstandings concerning propellers are due to this fact. In Fig. 6, *r* is the distance from the axis of the propeller of the section under consideration; *H* is the pitch measured from the zero line, *W* the velocity of the flow of fluid as it reaches the section under consideration. I call the pitch *H* when measured in the way indicated above

[1] D.Sc., University of Paris. Now acting in an advisory capacity to the Aircraft Administration, Washington, D. C.

effective pitch as opposed to the geometric or constructive pitch measured from the chord. Only the effective pitch can be considered as the geometric and real characteristic of the propeller, and the author fully agrees with Professor Brooks in that the only possible definition for slip is

$$s = \frac{H - (V/N)}{H} = 1 - \frac{V}{NH}$$

where V = velocity of translation
N = number of revolutions
H = effective pitch.

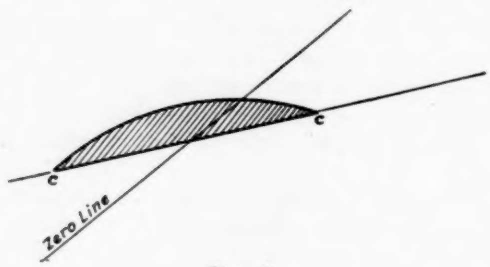

FIG. 5

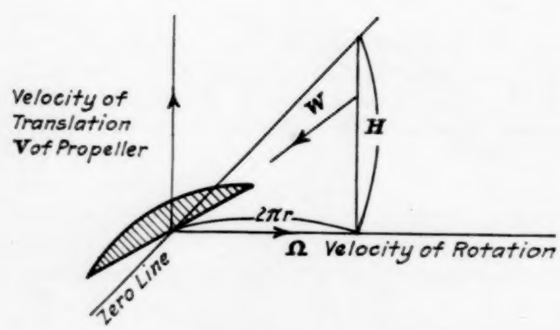

FIG. 6

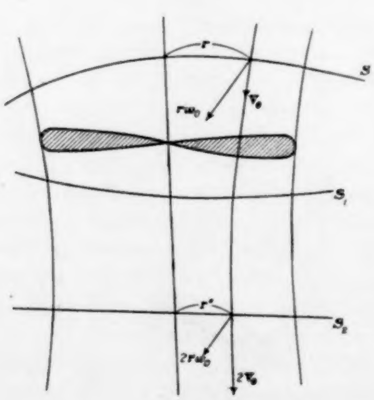

FIG. 7

It is the effective pitch which should be taken in measurements. The *effective pitch* is always greater than the *constructive pitch,* and that is why if for H in the above formula were taken the values of the constructive pitch, it might happen that negative values would be obtained for the propeller slip s, which is contrary to reason. The effective pitch, on the other hand, always gives positive values for s and the consideration of the effective pitch H is all that is necessary in order that the difficulties in the way of understanding the exact results of the experiments of Professor Brooks should disappear completely.

Let us consider the fluid stream generated by the rotation of a propeller; in particular, the case of a propeller rotating on a stationary basis (the following reasoning is, however, perfectly general).

I designate by S_2 (Fig. 7) the furthermost section to the rear of the propeller and by $2v_0$ the velocity at one point of that section. $2v_0$ is the velocity of the fluid parallel to the axis of rotation at the given point and $2r''\omega^2$ is the tangential component of this velocity. The real movement of the fluid is obviously helicoidal.

I show elsewhere that the section S in which the velocities of the fluid are v_0^2 and $r\omega_0^2$, that is, exactly one-half of the velocities at the section S_2, must be located necessarily in the front part of the propeller and at a certain distance from it. The propeller is, therefore, necessarily comprised between the sections S and S_2. The section S_1 is that which the eddy phenomena created by the propeller have already ceased to exist and the flow of air has become regular once more. The flow ahead of S is also regular, and my theory gives the exact values of the velocities v_0 and rw_0 (or $2v_2$ and $2r''\omega_0$).

The following are the values above referred to:

$$v_0 = r\Omega_0\varsigma_0 \tan(\varphi + \beta_0)$$
$$\omega_0 = 2\Omega_0\varsigma_0 \tan^2(\varphi + \beta_0)$$

These formulæ will show, in the first place, in accordance

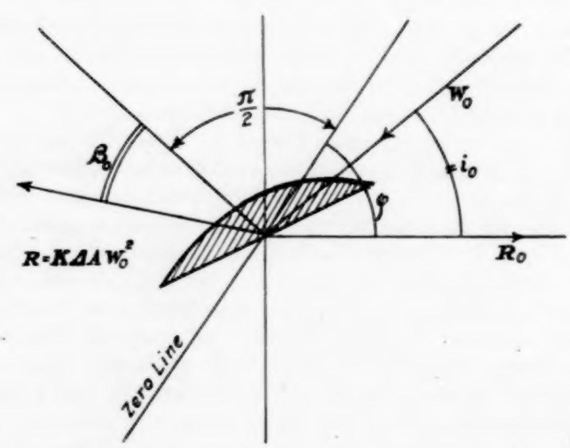

FIG. 8

with the experiments of Professor Brooks, that the ratios v_0/Ω_0 and ω_0/Ω_0 are independent of the number of revolutions $N = \frac{\Omega_0}{2\pi}$. In these formulæ

$$\varsigma_0 = \frac{\frac{1}{2}\Delta M (2v_0)^2}{\Omega_0 \Delta C_0} = \frac{v_0 \Delta Q_0}{\Omega_0 \Delta C_0} = \frac{\tan(\varphi - i_0)}{\tan(\varphi + \beta_0)[1 + 2\tan(\varphi - i_0)\tan(\varphi + \beta_0)]}$$

and with i_0 secured from this ratio, we have

$$a = \frac{nb}{2\pi r} = \frac{2\sin^2(\varphi - i_0)}{k_t \cos(\varphi + \beta_0)}$$

These formulæ contain by implication the fact that the velocity at a certain point in the fluid depends only upon the characteristics of the section of the propeller blade swept over by the fluid stream passing at that point, which is true as long as the radial velocities are negligible.

In these formulæ $\triangle Q_0$ and $\triangle C_0$ are the thrust and partial couple which correspond to the section of the blade under consideration and $\triangle M$ is the fluid mass which in a unit of time

passes across the annular space swept over by the section under consideration.

Let

φ = the angle of inclination of the zero line of the section under consideration on the plane of rotation

i_0 = angle of attack

k_i and β_0 are the aerodynamic characteristics of the section under consideration (Fig. 8)

n = the number of blades

b = the width of the blades

nb = the total width.

These formulæ for v_0 and w_0 show again that the fluid stream generated by the rotation of a fixed-base propeller is geometrically similar to itself, independently of the velocity of rotation of the propeller, and the rear angles of attack i_0 are independent of the value of Ω_ω. The values of the angles i_0 depend only on the shape of the blade and its pitch.

I have already by experiments confirmed the values of v_0 and w_0 given by my theory.

S. W. STRATTON[1] (written). The type of propeller employed by Professor Brooks in his experimental work differs so widely from the types in actual use that the extent to which the air-bat concept can be applied to propeller design cannot be foreseen. The new viewpoint is stimulating and suggestive, and especially welcome in connection with airplane propellers, where it is difficult to visualize what is actually taking place.

L. R. GULLEY (written). It was the writer's good fortune to observe a few of the tests made by Professor Brooks, the results of which form the basis of this paper. On first examination, the most evident proof of the superspeed effect was the result obtained from the air helix or propeller arranged with short blades of such width that the entire circumference of the propeller was covered.

This arrangement prevents inert air from passing through the propeller, and would normally be an ideal condition for screw action as applied to hydraulic propellers. Anemometer tests, however, proved that the air was driven from the propeller in a reducing stream at a velocity in excess of the calculated amount derived from blade pitch and rotational speed, while the approaching air was drawn in radially toward the propeller.

The results clearly indicate the reflecting action of air, due no doubt to its volumetric elasticity, and it would seem that further research should develop data of value not only in the design of propellers, but also in improving wing action, and possibly reducing head resistance of the stationary parts of the airplane.

J. C. HUNSAKER[2] (written). Professor Brooks' statement in his introductory paragraph that "the accepted theory of air propulsion does not accord with the facts," is not substantiated in his paper.

The aerofoil theory as set forth by Lanchester and Drzewiecki, and now commonly used for the design of propellers, requires no assumption as to how an aerofoil element obtains its thrust, but bases the evaluation of this thrust on actual aerodynamic tests. Professor Brooks in his paper makes an issue of the fact that calculated and actual propeller performances do not agree. This may well be accounted for by the necessary approximations made in design regarding indraft and a lack of definite knowledge of the action of the air at propeller tips and hub.

[1] Director, United States Bureau of Standards.

[2] Naval Constructor, U. S. N., Bureau of Construction and Repairs, Washington, D. C.

Professor Brooks' reflection theory, while it need not con iet with the aerofoil theory, is open to criticism. The assumption is made that particles of air act as independent bodies and not as parts of viscous fluid, and that they rebound from the propeller blade without interfering with the surrounding air. Photographic investigation of the flow of air around models does not show that any rebounding action affects materially the shape of the stream lines. Moreover, a rebounding action from the surface of an aerofoil is not in accordance with Dr. Prandtl's elaborate experiments demonstrating the existence of "bounding layers," nor does it harmonize with the "vortex theory of sustentation" which has been verified photographically.

In the first paragraph of his paper Professor Brooks says that the theory of marine propulsion has been transferred to air propulsion without sufficient regard for the extreme difference in the two fluids as to elasticity. As previously stated, the design of a propeller is based on aerodynamic tests of the particular blade sections employed. Any effect that elasticity of air may have on air-propeller performance is accordingly taken care of in the choice of the proper blade section. There is extensive experimental proof that within certain limitations the same dynamic laws hold for water and for air. Perhaps the most striking example is afforded by a comparison of photographs of flow of air and water by models (Eden British Report No. 49). (In my paper given before the International Engineering Congress, 1915, I showed that the compressibility of air is mainly of theoretical interest.) A comparison of propeller tests made at the Navy Yard, Washington, with tests made by Dr. W. F. Durand, shows that there exists a close agreement between propellers tested in water and those tested in air and that it may be sufficient in particular cases to apply a correction only for the ratio of densities as the compressibility of air is not a serious factor. The important effect of viscosity was not considered in Professor Brooks' paper.

Regarding the conclusions drawn by Professor Brooks for static propeller tests, the following may be said:

No account was taken in his demonstration of "superspeed" for the acceleration of the air before coming in contact with the propeller blade. In consideration of tests made at the National Physical Laboratory and by Eiffel, Professor Brooks' theory does not seem to warrant the neglect of "indraft."

A prediction of full-flight performance from a single static test as suggested does not take into account the critical changes which occur in the thrust of a propeller, as the angle of attack of the blade varies, due to a change in the velocity of translation. It is not clear how a static test can foretell flying performance unless the aerodynamic properties of the particular blade are known.

M. B. SELLERS[1] (written). When a propeller is constructed having zero pitch, that is, the face or driving side exactly parallel to the plane of rotation, and having the usual cambered back, it is found that this propeller exerts some thrust and delivers a considerable blast of air. Of course, there can be here no batting action, and yet we have a blast, due, in my opinion, to the fact that the rarefaction at the trailing edge on the back of the blade initiates an air stream. If now we try a similar propeller, but with an appreciable pitch, we find that the air stream now produced is approximately the sum of that due to the cambered back plus that due to the pitch. On the other hand, if we employ a propeller having a blade flat

[1] Member Naval Consulting Board of the United States, Baltimore, Md.

back and front, the velocity of the air stream, correctly measured, will about equal the geometric-pitch speed. It would seem to me, therefore, that the increased velocity of the air stream observed is not due to batting action, but to the effect of the rounded back of the blade.

LIEUT.-COL. J. G. VINCENT[1] (written). I have submitted this paper to our propeller expert, F. W. Caldwell, and have asked him to give me a brief report, which he has done as follows:

"We have had some correspondence with Professor Brooks in regard to his theory of propeller design. He seems to be working under the impression that we wish to produce a noiseless propeller regardless of its efficiency.

"The first model propeller submitted by Professor Brooks to the National Advisory Committee of Aeronautics showed an efficiency of only 38 per cent in contrast with a model of Professor Olmstead's which showed an efficiency of 89½ per cent.

"Professor Brooks' paper is interesting from a theoretical standpoint, except that he seems to have drawn the wrong conclusion from his investigations. He seems to be under the impression that propellers with small diameters will produce good results, whereas all experience and all the usual propeller theories show that under most flying conditions the greater the diameter of the propeller, the better the efficiency obtained."

WALTER C. DURFEE (written). The most interesting explanation of superspeed as noted by Professor Brooks is in terms of the contraction of the jet or blast shown in his Fig. 3. It seems certain that the velocity of flow actually among the propeller blades cannot be great enough to drive the propeller any faster than it is being driven by the motor, unless the apparatus is acting as a windmill and the driving mechanism acting as a brake. The observed superspeed then is acquired immediately after passing the blades or may even exist to an extent at the blades, but in oblique directions. The contraction of the blast shown in Fig. 3 corresponds to a doubling of the speed of the propeller blast almost immediately after leaving the propeller.

An interesting explanation of this contraction and acceleration of the jet speed may be had without detriment to explanation in other terms by trying to study the action of the jet upon itself. The blast of a propeller of low pitch or of many blades is approximately a continuous jet or stream of variable cross section. To describe it we may use the language of vortex motion. It is the same jet in any language. At its center this jet contains a complicated system of vortex motion corresponding to the internal rotation of the jet and the comparative lack of motion along the central axis.

The outside surface or sheath of the propeller blast is the seat of a second vortex system which is mainly responsible for the velocity of the blast and for the annulment of rotation and velocity in external regions. This outer system, which mainly determines the velocity of the jet, coils like a helix around the blast, with its origin at the propeller tips, much like the two serpents which coil about the "caduceus" or winged wand of Hermes, their two heads beneath the wings. Imagine these two serpents or snakes to grow interminably, continually fed from the propeller blades and their bodies rolling along as vortices between the jet and the outer air. Imagine too that every particle of moving air is the servant of these serpents and that the serpents themselves writhe with a motion exactly determined by the influence of all the neighboring coils. The result is a simple example in turbulent motion. The exact calculation of the motion of the serpents or vortices is not without importance if it can be accomplished. The thrust of the propeller, for example, depends on its angle of attack against the relative wind, and this relative wind is the abject slave of the serpents or vortices which feed on the propeller.

For the purpose of studying the reason for the contraction of the jet as mentioned by the author we may imagine that the jet is momentarily made straight and uniform like a pipe, i. e., uniform vortex coils from end to end. Under these conditions there is a collapsing motion at the entrance or beginning of the jet because the motion of the air here is due to the vortices immediately in front which roll inward as viewed from the propeller. The velocity also in the supposed straight-walled blast may be studied. A forward component is provided by all the vortex coils. Within the tube the in uence of these is felt both in the front and in the rear of any point, so the velocity is greater inside than at the entrance to the tube where the influence is only in front. On the whole, the action of the jet upon itself is in favor of a contraction near the origin, and in favor of somewhat slower motion at the entrance than at a point a little within the jet.

If we could persuade a professional mathematician to "bell the cat" for us it would indeed be a splendid achievement to become able to calculate superspeed as Professor Brooks has suggested will some day happen. Until we can get the exact formulæ which he foresees, I think we should congratulate him very heartily on providing us with useful data on the subject of superspeed.

Mr. Durfee prefaced the presentation of his written discussion by saying that he wanted to defend Professor Brooks' ideas, and to do this the simplest way was to explain practically all the nine different theories of the action of the air going round a blade of a propeller. These theories were: The Screw, Bat, Vacuum, Stream-Deflection, Momentum, Hydraulic, Purely Mathematical (with variations), Impulse, or Side-Pressure, and Vortex, or Whirlwind theories.

The screw theory assumed that air is very nearly solid, on account of its inertia. The propeller was assumed to screw through it as if it were a block of wood. Next the additional

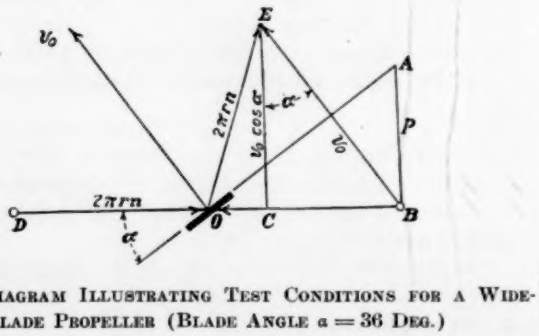

FIG. 9 DIAGRAM ILLUSTRATING TEST CONDITIONS FOR A WIDE-BLADE PROPELLER (BLADE ANGLE $\alpha = 36$ DEG.)

assumption was made that the air is not solid, that it has some slip. This we knew from experience.

The bat theory took account of the motion of the air after it left the blade, and if Fig 9 (Fig. 1 of the paper) were examined, it would be seen that the author had shown the reaction against the blade as perpendicular to the surface. It did not make much difference whether it was a baseball, or a sand blast, or a stream of air; there was not much friction to that surface and the reaction was substantially normal to the

[1] Chief Engineer, Airplane Engineering Dept., Signal Corps, U. S. A.

surface. It had to be. It would also be noticed that the velocity *DO* branched off and became motion *OE*. In other words, the stream of air did not lose much energy as it went past, and as far as the mathematics showed, he saw no difference whether it was a baseball or a sand blast or a stream of air. There was not much energy lost; the reaction had to be in about the same direction. He thought the origin of the criticism of Professor Brooks' theory was the feeling that if air consisted of a number of particles they could not all come down to the surface and go back to the same space. There could not be two directions in the same place.

The vacuum theory was based on experiments which showed that the partial vacuum on the top of the wing was numerically larger than the positive pressure underneath the wing. The difference in pressure held the wing up. It was not the vacuum, it was not the pressure; but it was the difference between the pressure below and the vacuum above.

The stream-deflection theory assumed that a stream or layer of the air came along and struck the inclined plane, i. e., the propeller blade, and was thus deflected. The question was: What supplied that force? The trouble with the theory was that one had to decide how big was that stream. The active stream merged into the surrounding air, and it was necessary to assume a stream and guess its proportions and how it was deflected.

Exponents of the momentum theory said, "Never mind what happens around it. If the air strikes against the blade, the air is going down behind it; how fast it is going down is told by the slope of the blade." They calculated the weight of air and how fast the blade was going down with the weight, how much impulse must have been supplied to produce that motion, and they obtained a result.

What he called the hydraulic theory of this sustentation was this: Where the water was going fast through a venturi tube there was a low pressure; where it was going slow there was a high pressure. With a thick wing such as the author mentioned, one could readily imagine that the air went a little faster over the top than over the bottom. Therefore, from the simple theory of hydraulics one could calculate where the pressure was low and where it was high. This pressure difference lifted the wing. The hydraulic theory had advantages when one was calculating the action of a propeller in a pipe. The ordinary theories could not be used as in the open where the air was supposed to stand still and be hit; the back pressures, etc., must be considered.

The mathematical theory assumed a perfect fluid: Find what a perfect fluid would do and thus learn what a real fluid would do. Lord Kelvin had said: "Here is what a perfect fluid will do. My guess is that if the air had a little bit of elasticity or a little bit of viscosity this action would not occur and a totally different action would take place." Then he proceeded to tell what it would be.

H. F. Hagen said that the screw theory as mentioned in the paper, with the idea that a screw went through a solid mass either in air or water, had never been used by any designer or scientist. As originally presented by Rankine, it allowed for a certain slip. The term slip, however, was rather unfortunate. We were accustomed to say that a propeller could not do any work unless it had a certain slip, but it would be much better to say that a propeller could do no work unless it had produced rotation in the direction of the rotation of the screw. That had been proved by a number of investigators and to disregard it would be entirely incorrect.

The vacuum, stream-deflection, momentum, hydraulic and mathematical theories enumerated by Mr. Durfee he thought could all be combined under the term "stream-line theory." Professor Brooks' theory did not take account of the discharge side of the propeller, and as the speed of the fluid on the discharge side was certainly faster than the speed of the fluid entering, there could be no continuity. That would require water to be broken up into droplets, or air to behave like a cloud of non-interfering dust particles. The chief objection to this was that air or any other fluid did not work that way. Any one who had ever observed the flow of smoke around the blade would have noticed that there was only one stream line really that touched the blade—the others were formed flowing around smoothly.

Any propeller theory to be complete ought to explain both the action in air and water. Both were fluids and the difference between them was not one of elasticity but of compressibility. Air was compressible, water practically non-compressible. Making due allowance for compressibility, density and viscosity it should be possible to predict the performance of the air propeller from that of the water propeller. There were questions as to the latter regarding the shape of the stern of the vessel, the free surface of the water, and the bottom, which all combined, so that although the general theory might bring the two together and reconcile the airplane propeller and the water propeller, he doubted very much whether tests on water propellers could ever be used for air propellers, because although the stream lines might be similar, yet it would be impossible to transfer any quantitative results from one to the other.

Mr. Hagen then entered into the discussion of the air-propulsion theory propounded by Rateau, which, he said, was about the most satisfactory one that had been presented. Owing to time limitations, however, he was unable to complete his remarks but promised to present them later in writing.

A FOUNDRY COST AND ACCOUNTING SYSTEM

Discussion of Paper by Prof. W. W. Bird

In Professor Bird's paper a foundry cost and accounting system was outlined which has been developed as a result of experiments carried on in the commercial foundry at the Worcester Polytechnic Institute. The system, the author stated, is giving good satisfaction and has been found to be thoroughly reliable as a signal system. It is based on the principle that the three most important items of cost are core labor, molding labor and pounds of castings produced, and that each of the other items of cost is a function of one of these. All of the work involved can be done by the regular clerical force of the foundry in a small amount of extra time.

Written discussions of the paper were presented by Benj. D. Fuller, R. S. Denham, R. E. Newcomb and M. J. House, and it was orally commented upon by Dr. R. Moldenke, Malcolm Libby, Wm. L. Walker and William Kent. These discussions are given below.

Benj. D. Fuller[1] (written). The cost system presented by the author is in the right direction and probably satisfactory as an accounting guide for a foundry such as the one where it has been applied; but in my estimation it does not go deep enough to be thoroughly successful in accounting for the costs of a large concern. Too little attention is paid

[1] President, American Foundrymen's Association.

to the question of overhead distribution, which is a very important factor.

Overhead is in some cost systems carried entirely as a percentage on direct labor cost; in others as a percentage added to poundage or weight. A more equitable distribution is to divide, carrying a percentage on labor and another percentage on weight. Some castings require an excess of labor for a minimum of weight, in which case the labor overhead would be the larger in the accounting, and justly so. But imagine a casting of excessive weight and a minimum amount of labor, such as a large floor plate cast in open sand. Here the weight basis of overhead would, in accounting, rightly carry the bulk of load.

Cost systems giving individual casting costs are much more valuable than those where the output is handled in bulk or weight classifications.

In the third paragraph of the paper it is stated that "the three most important items were core labor, molding labor, and pounds of castings produced." To these should be added cleaning labor, which varies widely in cost with the class of work.

The fifth paragraph says that in the general scheme used an account is charged with the amount of the purchases made during the month. Payroll charges in connection should not be forgotten.

In the sixth paragraph it is said that "All expenses are charged to the Expense Account." There should be sub-accounts for the various classes of expense to care properly for these charges.

The items Core Work, Molding, and Metal and Melting which the author uses in his records, should each carry a share of building repairs, light, heat, depreciation, insurance, taxes, administration, etc.

Robert S. Denham[1] (written). Product of whatever kind, consists of materials and the time of formative processes. In this paper the material is Metal, and the formative processes are Core Making, Molding, and Melting.

By analysis we find that the handling of materials or metal involves the expenses of transportation, handling labor, rent of stock yard or room, interest and insurance on investment in material, shrinkage, etc.

Analysis of the formative processes will show that each requires more or less of the following expenses: Rent, heat, building repairs; depreciation, interest, insurance and taxes on equipment, power, light, water, ice, compensation insurance, supplies, repairs to equipment; wages of workmen, etc.

Administration and selling expenses include salaries, advertising, office supplies, telephones, bad accounts and collection expenses, discounts, commissions, etc.

Further, there must be consideration of the expenses of packing and delivering the product to the local consumer or freight house.

Professor Bird arbitrarily selects the process of core making and charges it with the expenses of wages and supplies, the latter being charged on the basis of 30 cents to each dollar of wages paid to coremakers. None of the other expenses is considered in connection with core making.

He then burdens the molding with all of the other expenses of the business, including all of the operating and administrative expenses required by the core making and melting except an unexplained charge of 30 cents per 100 lb. on the melting process. His basis for the charge of this mass of unrelated items is the wages of the molders.

[1]Consulting Cost Engineer, Cleveland, Ohio.

For some reason, also unexplained, he selects the items of supplies from the mass and charges for these at the rate of 6 per cent, while what he calls "Expense" is charged at the rate of 75 per cent on the wages of molders. Since both have the same basis in his plan the same result would be obtained by a single charge of 81 per cent.

A practical degree of exactness is essential in a matter as vital as the cost of production, and the writer holds the following principles to be fundamental:

1 The cost of an item of product is the sum of the expenses involved in its production and distribution up to the moment at which cost is determined.
2 Every cost element (expense item) is definite in amount, and purpose, and anticipates a beneficial equivalent in service or commodity.
3 In the distribution or charging of expenses consideration should be given to the benefit derived that the charges may be justly assessed where the benefit is conferred and in true proportion to the measure of benefit.

If each of the above-mentioned items of expense be now considered it will be found that not one of them bears a relation to wages such that the benefit conferred by the expenditure increases or decreases with fluctuation in wages, or as between the product of men receiving different rates of wages. Neither is there a relation between the wages paid and the total of these items applicable to the product of the workmen.

No scheme of cost accounting which involves the distribution of a mass of expenses under the title of "overhead" or "burden" will bear analysis. The correct determination of cost of product can be accomplished only through the comparatively new analytical method known as Cost Engineering, in which each process is considered separately and each item of expense individually applied by measurement so that expense and benefit are in identical proportions, making it impossible for one process to carry any of the expense belonging to another.

Robert E. Newcomb (written). It is axiomatic that in the management of any business, facts, not surmises, must form the basis for operating.

While the costs of core materials, molding materials, expense and melting may be functions respectively of the core labor, molding labor and pounds of castings produced, they are at the same time variable functions and hence, basically, surmises which cannot form an accurate basis for operating.

The object of cost accounting is to establish and fix profits, and a cost system should strive to get the absolute facts and figures. To arrive at proper cost, the following well-established formulæ must be used:

Cost of Material + Direct Labor = Prime Cost
Prime Cost + Direct Factory Expense = Factory Cost
Factory Cost + General Expense = Cost to Make
Cost to Make + Selling Expense = Cost to Make and Sell

and in foundry cost accounting it is essential that the cost be built up from the following items representing the total of accumulated details: Core Labor, Supplies, Mold Labor, Chipping Labor, Miscellaneous Labor, Melting, New Metal, Scrap, Other Expense, each item in sum total.

The accumulated details should be obtained from the record of the actual number of units of material used from day to day and the actual number of hours of labor. The cost of material delivered during a current cost month should not be used as a basis of establishing costs, as is apparently suggested by the author, as it would not give a true cost for the

reason that the material entering the castings, especially in a foundry carrying a stock of iron, may have been delivered at a price differing considerably from the cost for the current month. This difference in price may make a considerable fluctuation in the selling price, which would apparently cause the foundry using this method to quote both low and high prices at the wrong time. A better method would be to average the cost of the pig iron and material in stock, preventing fluctuation in apparent cost and selling price.

As a signal system to indicate the drift of the cost, a daily estimate may be made based as follows, assuming a specific case for illustration:

Let M = total number of men = 175
T = total melt in tons = 35
P = average proportion of good castings in melt = 0.7
L = average cost of labor per man-hour = \$4
I = average cost of metal at ladle per ton of good castings = \$25
S = average cost of supplies per ton of good castings = \$10
m = average men per ton of good castings $= M/(T \times P) = 175/(35 \times 0.7) = 7.10$
l = average labor cost per ton of good castings $= m \times L = 7.10 \times 4 = \$28.40$
C = total cost per ton of good castings $= l + I + S = \$28.40 + \$25.00 + \$10.00 = \$63.40$

The above figures are actual or based upon the previous month's accurately established costs, and from day to day are reasonably reliable signals indicating to the live foundryman the drift of the cost for the current month; and in the respect that they are available from day to day corrective measures may be taken to reduce greatly increasing costs before having run to a disastrous extent.

M. J. HOUSE[1] submitted an extended written discussion of the paper, in which he indicated wherein it appeared to him that the author's plan failed to provide adequately for cost and accounting requirements under the ordinary conditions of a commercial foundry.

While not doubting in the least that, as stated, the system was giving excellent satisfaction, that the data it kept before the foundry officials were thoroughly reliable according to the plan and that clerical work required but little extra time, it did not follow that the costs were "fairly accurate." Numerous systems were in use which fully satisfied those who used them and, in many plants, statistical data of great importance were compiled, yet the costs obtained were far from dependable.

In the third paragraph the author set up three independent variables, namely, Core Labor, Molding Labor and Pounds of Castings Produced, as the most important ones and considered all other items of cost as "functions" of some one of these.

As a general proposition, however, there were seven variables equally important, owing to their direct influence on costs although not in like proportions. These seven were Pattern Labor, Core Labor, Molding Labor, Melting Labor, Cleaning Department Labor, Materials and Supplies and Pounds of Castings Produced. Like a majority of founders, the author ignored the fact that labor employed in the pattern shop was directly related to production, was chargeable directly to jobs or classes and was not an item to be prorated over production as a whole if of consequence; there was no more reason for doing so than for the diffusion of Molding Labor in the same way.

[1] With C. E. Knoeppel & Co., New York City.

The difficulty referred to in respect to split payrolls, Mr. House believed, was more imaginary than real; as, if accounting classification was properly devised and followed, the manufacturing accounts might be tied in with financial records without use of split payrolls and the twelve cycles for comparison annually might consist of two periods of four weeks and one of five weeks each three months.

He was not prepared to dispute the statement that the cost of melting varied directly with pounds of castings produced, but unless the quantities of the several patterns cast were identical each month, he was at a loss to understand how such a result could be achieved, as the cost of melting actually varied according to quantities of gates, sprues, defectives, over-metal etc. Unless the product was practically uniform from month to month, the melting credit could not possibly parallel the production.

Mr. House then outlined a cost accounting plan that he had found to be very simple, highly accurate and easy of application. In it melting and departmental expense rates were predetermined, all expense was concentrated into six rates and—when cost computations were made—which might be at any time a lot of castings was finished, the only factors to be dealt with to obtain Shop Cost were Metal and Castings, Direct Materials, Direct Labor, Departmental Rates and—sometimes—special costs in the form of patterns, flasks or other special rigging.

R. MOLDENKE. I find that Professor Bird's work, while of an extremely varied character, is still a work which is a continued operation. His cores and molds are about the same all the time; there may be large castings and small castings and varied work, but they repeat themselves to an extent that will allow him to draw his conclusions. This system is good for his work but may not be fit for different work, and these discussions fall back on the fact that they want more exact cost where the work varies, whether there are few castings or many castings. The pilot-light system is a good one when applied to current practice. We want to know costs as exactly as we can get them. There comes a time when it may be good to get some percentage division, particularly of the overhead in the nature of the work. For instance, few shops differentiate from the ordinary floor plate of the engine bed or light casting. It is important that they should do so because the overhead should be differently distributed from one class of work to another. It may be found that line work is produced at large cost but small profit. There should be a division of the work into classes. Then comes the system of Professor Bird to distribute the overhead, particularly after some of the fundamental costs on the different classes are known, to show which line of work should be continued. I like the paper because it attempts to give a method of finding a system which will tell quickly whether one is making or losing money.

MALCOLM LIBBY. It is to be hoped that Professor Bird will present at an early date this question of prices and bids because it would make clear many of the points of the paper, and in the discussion especially so, inasmuch as the judgment which is made on the foundryman, i. e., the superintendent's efficiency and capability, involves several factors. He mentioned an all-important one, namely, the selling price turned immediately back to production. Some companies are in a fortunate position in that they are able to establish the market price. Their cost systems must involve the principle which covers the ques-

tion of determining the price quite as much as determining the costs.

WILLIAM L. WALKER. The idea of connecting the cost-accounting system with the accounting department, and being sure that in the costs in the foundry all the expenses found in the account books are so used, is important. Many plants have cost-accounts systems based upon the estimated account. The costs are never carried into finance—the books closed, but at the end of each year there appears a large balance of unabsorbed expense. In Professor Bird's foundry the work likely goes along about the same, and the element of error entering into the factor of indirect overhead expense would not be as great as in a large foundry producing many items where there are different kinds of furnaces, of molding machines, and of departments. It is necessary to distribute the overhead expense by departments, by various types of operation, and put it there as an indirect cost, allowing for space cost, building depreciation, insurance, taxes, repairs, and other items entering into the expense. By a system of classification of expense these items may be put in the account records. In any cost system we can not get absolute accuracy—it is impossible. Costs can be put on in a manner that will show the results as nearly accurate as it is practical to go, i. e., to where it does not cost more to get the cost than the actual difference in the method involved.

WILLIAM KENT. For the purposes of this particular foundry this system may give a close enough approximation to what Professor Bird wants to get; but I agree with the speakers who have preceded me in saying that the system will not do for any foundry operated on different kinds of products, and that some other system must be used. The objection to his method is that he uses factors and percentages. Generally speaking, averages and percentages and factors should be avoided. What we want is items summed up into totals and these totals put into proper reports, and if possible charted so that we can see how things are going. The idea of using an accounting system as a signal is good. The best signal is found not in an accounting system, but in the reports of tonnages and other items that are put in a table of monthly averages. The discussion will contribute largely to the value of the paper.

THE AUTHOR. I do not believe in the cost system. If you want to see how our system works, go to our office. If those who criticize this paper can show a system comparable with ours in regard to the cost of keeping this system, I challenge them to bring it along. Our bookkeeper runs off this balance sheet, and he does not know anything about the foundry business, yet when the trial balance is made up we have our result. There is no other system that will give anything like that. I have made a study of the foundry business; I am president of the Broadway Iron Foundry, Cambridge, Mass., where we have used the system fifteen or twenty years. It is not a question of cost. We want to know if we are making money. This paper describes a cost-of-account system. This is a cost system based, or which starts, if you will, on the top of a pyramid. All the cost systems I have ever seen start at the foundation. We start at the very top. How much did you make last month? We have it immediately. I am glad one of the speakers pointed out that it is essential that costs should be tied up with the accounting system. That is seldom done. Some one asked why we did not put something in about labor. We consider that we purchase our labor; the labor is in the purchases. Understand, the paper deals with a cost-of-account system, not a cost system.

AN INVESTIGATION OF THE FUEL PROBLEM OF THE MIDDLE WEST

DISCUSSION OF PAPER BY A. A. POTTER

IN this paper the author showed by figures received from numerous power plants in the Middle West that their increased cost of producing power during the past winter was due to: *a* The increased cost of fuel; *b* The necessity of burning fuels of different grades with equipment suitable for one particular grade; *c* The greater amount of ash and other non-combustible matter; *d* The increased cost of labor and the poorer quality of labor available; *e* The increased cost of repairs, supplies and new equipment.

He then discussed the effect of increased expenses and fuel scarcity on isolated plants, detailed the various efforts which have been made to obtain better fuel economy, and outlined the work accomplished by the Fuel Administration Boards of Iowa, Louisiana and Illinois.

His conclusions were that future emergencies in the Middle West plants could be averted by more adequate fuel storage, by greater attention to fuel economy, and by the more careful regulation on the part of the Government of the quality of fuel leaving the mines and of the fuel-transportation facilities.

Written discussions embodying pertinent comment were contributed by Alex. D. Bailey, John D. Riggs and E. A. Uehling, and are as follows:

ALEX. D. BAILEY (written). Referring to the second paragraph of the author's conclusions, the cost of $15 per ton capacity for subaqueous coal storage pits might be very discouraging to anyone considering for the first time the storage of coal, as under ordinary methods of figuring fixed charges this would mean an annual cost of at least $2 per ton for the coal-storage equipment, exclusive of handling. Using locomotive cranes for handling coal into and out of open coal piles on the ground, approximately 10,000 tons per acre can be stored, and the depreciation due to weathering would be negligible compared with the cost of subaqueous storage plants.

By storing only screened or washed coal the danger from spontaneous combustion is reduced to a minimum; further, it is advisable to store the best coal obtainable, as in this way the maximum heat value is obtained per dollar invested in land and coal-storage equipment as well as in the coal itself. This applies also to the cost of handling, as good coal can be handled as cheaply as poor coal, both into and from storage, as well as in the boiler room, and as this storage is generally used under emergency conditions, when weather conditions are unfavorable, and when not only the coal-handling equipment but the operators are taxed to their utmost, the maximum return is assured for each ton of coal handled.

It should be borne in mind also that storage coal is generally required during extremely cold weather when shipping facilities are hampered and when everything is badly frozen. For this reason precautions should be taken to keep the storage as dry as possible to facilitate handling, as it can be readily seen that coal which is flooded in a storage pit, and frozen solid, will be unobtainable when needed most.

JOHN D. RIGGS (written). In regard to proper furnace design for small one-boiler plants using high-volatile coal, it has been observed that the combustion chamber is usually too small when working near full capacity, but ample at half load or less. This trouble may be partly overcome by having a rather large grate area, and bricking over a portion of it

when working light. It would seem that better arrangements might be provided for lowering the grates and bridge wall in the fall, and for raising in the spring of the year, or when the load is to be light for a time. We think it is quite common practice with men accustomed to such coals to use a thin fire, and not attempt to crowd the boiler. With some other bituminous coals, especially the "dry-burning," we have noted the use of smaller grate surfaces, much thicker fire bed, higher chimneys, and a tendency to crowd every working boiler to the limit, even where a plant has several extra boilers.

During the past winter some householders had to burn bituminous coal of one class for a period of perhaps twelve days, then change to another class for a similar period, and then change again, until when spring finally came, we found that about six varieties of fuel had been used, some bearing unfamiliar names, and one lot with no name at all. The net result of this may be estimated as 30 per cent extra coal on account of an unusual winter, and another 30 per cent extra on account of unusual conditions, beyond control.

Now comes the slogan, "Buy Your Fuel Early." This is common practice for the man who heats with coke or anthracite, but not at all for the one who uses many of the western bituminous coals, and even dangerous practice to some men who have often seen an outside coal pile at a power plant on fire. Such fires seldom do much damage at the power plant, but may lead to the destruction of a home.

E. A. Uehling (written). Early in the paper the author says: "Suggestions have been made by power-plant engineers that the Fuel Administration should regulate the supplies from the different mines in such a manner that individual plants would get their supply of uniform grade." This would be a wise procedure if it could be carried out, but in the case of acute fuel shortage, when whatever is available must be taken, it will not work out. The Government's zoning proposition if properly carried through should operate in favor of this suggestion.

It goes without saying that it is more difficult to burn heterogeneous mixtures of coal efficiently than coal of a uniform grade; but even the most uniform grades of coal are liable to vary appreciably in their ash and moisture content as well in the ratio of coarse to fine, and will not run over the grates uniformly with the same stoker speed, and the air supply will therefore require frequent readjustments at best. The proper slogan for the engine room should be: *Watch your adjustments and keep them right and your results will be right,* but that for the boiler room must be: *Watch your results and change your adjustments to keep them right,* if attainable efficiency is to be achieved and maintained. There is no such a thing as fixed adjustments in the economic operation of steam boilers. Automatic adjusting devices do not and cannot produce maximum economic results.

The steam gage is the monitor of the boiler room. Combustion must be increased or decreased as its hand points below or above the standard pressure. The steam-flow meter indicates whether the boiler responds to the accelerated or slackened steam production dictated by the steam gage; neither gives any information as to whether the fuel is being burned economically or wastefully; but unless this information is continuously before the fireman, he is working in the dark, and the highest economy attainable under the prevailing operating conditions cannot regularly result.

The percentage of CO_2 in the products of combustion is a true index to combustion efficiency. It is a correct measure of the excess air supplied and the continuous CO_2 indicator at or near the boiler front is the only practical means by which the fireman can tell with any degree of certainty whether his draft is properly adjusted to meet the variable combustion requirements economically. I hold that a fireman can operate a given boiler equipped with a continuous CO_2 meter to guide him more economically, burning coal of variable grade and composition (within reasonable limits), than he can with coal of a normally even grade without such a guide.

Mr. Potter cites many instances where coal of abnormally high ash content was foisted upon helpless consumers during the fall and winter of 1917-1918 by unscrupulous coal operators, the coal in some cases carrying from three to six times its normal ash content. "In general," he says, "the ash content in the fuel used during 1917-1918 was at least 5 per cent greater than in former years, due to faulty methods at the mines."

When we consider how intensely the shortage of coal required by the industries was aggravated by the excessive ash and slate contents of the coal, and that the shortage was not due to lack of miners or mining facilities but to car shortage and transportation overburdened by something like fifty million tons of slate and the ten to twenty million tons of coal required to melt it into clinker-obstructing boiler operations, we should not let this catastrophe pass over by merely stating that it was due to "faulty methods at the mines."

When we further consider the retarding effect on the production and shipment of most vital and urgently necessary war supplies, the damage done to the industries of this country in general, and last but not least, the intense suffering caused to millions of poor and even many well-to-do people, I think the "faulty methods" should be stigmatized as nothing short of criminal profiteering, in comparison to which the notorious embalmed-beef scandal of our misconducted Spanish war was an insignificant episode.

Upon the recommendation of its technical committee the Compressed Air Society has adopted the following definitions of certain terms in order to eliminate confusion as to their exact meaning.

Displacement. The displacement of an air compressor is the volume displaced by the net area of the compressor piston.

Capacity. The capacity should be expressed in cubic feet per minute and is the actual amount of air compressed and delivered, expressed in free air at intake temperature and at the pressure of dry air at the suction.

Volumetric Efficiency. Volumetric efficiency is the ratio of the capacity to the displacement of the compressor, all as defined above.

Compression Efficiency. Compression efficiency is the ratio of the work required to compress isothermally all the air delivered by an air compressor to the work actually done within the compressor cylinder as shown by indicator cards, and may be expressed as the product of the volumetric efficiency, the intake pressure and the hyperbolic logarithm of the ratio of compression, all divided by the indicated mean effective pressure within the air cylinder or cylinders.

Mechanical Efficiency. Mechanical efficiency is the ratio of the air indicated horsepower to the steam indicated horsepower in the case of a steam-driven, and to the brake horsepower in the case of a power-driven, machine.

Overall Efficiency. Overall efficiency is the product of the compression efficiency and the mechanical efficiency.

The Society further recommends that the use of other expressions of efficiency be discontinued.

ECONOMIES IN MANUFACTURING IN THE CANNING INDUSTRY

By J. H. SHRADER,[1] WASHINGTON, D. C.

This paper, which was presented at a meeting of the Baltimore Section on March 12, 1918, outlines the general procedure followed in tomato canning and points out the numerous sources of loss. The manufacture of concentrated tomato products is described and in particular that of tomato paste, a seedless and coreless food product which, compared with ordinary canned tomatoes, cuts down the fruit waste from 50 per cent to 5 per cent, requires much less labor in its preparation, saves two-thirds of the expenditure for tin plate and greatly reduces shipping costs.

At the same meeting a paper entitled Investigation of the Uses of Steam in the Canning Industry was presented by Prof. Julian C. Smallwood, of Johns Hopkins University, which was again presented at the Spring Meeting of the Society in Worcester and printed substantially in full in the May issue of The Journal. In this paper Professor Smallwood analyzed the different heat processes employed in the canning of food, described the various forms of apparatus used, and pointed out actual and ideal steam consumptions and methods of minimizing waste. The two papers taken together form a valuable survey of the present technical status of this important food-preserving industry.

When one interests himself in the manufacturing aspect of the great steel industry, he finds the whole procedure made up of a number of more or less isolated processes each complete in itself but contributing its share to the completion of the whole. He sees machinery everywhere and most intimately connected with the whole process of steel manufacture from extracting the iron from the ore to turning out the finished goods. As perfect as the whole operation seems, the intelligent investigator will not be surprised when told that the technologists operating the plant can point out most serious deficiencies in many places, and that the whole staff is continually striving for improvements. One also expects to find great technical developments in the copper industry. Large engineering and chemical staffs are employed to devote all their time to surmounting difficulties and controlling operations. In these great industries we expect complexity and its attendant problems.

But when one considers such industries as that of canning, he naturally wonders where there might be any difficulties of moment, and where there can be the need for much mechanical application. Surely, if the activities of our wives and mothers during the canning season are any criterion, the whole procedure seems simple enough. So seems the iron industry when one seeks to make 5 lb. of iron in a day or two, with a whole forest back of him for charcoal and no time factor to be troubled with. It was the economic pressure of quantity against time that forced the ironmasters from counting pounds to counting tons. The same conditions forced food manufacturing likewise from the pound basis to that of tons. But the necessity of this capacity consideration is only the first of a number of problems. If the ironmaster unexpectedly has an extra lot of ore dumped at his plant, or if his plant shuts down for any reason, the iron ore can be readily stored until such time as the superintendent calls for it. His operating season is the whole year.

The canner, however, figures on a brief season of a few months of intensive effort in which he has to make whatever he can and then close up and wait three-quarters of a year until the next season. Consequently he plans to keep his plant running nearly to capacity while the running is good. Any unexpected glut of raw material together with factory shutdowns always accompanying capacity stride means a slip somewhere—either a loss due to inefficient operation or spoilage, or both, for raw food products can not be readily stored but begin to spoil before they are well on their way to the factory. It means get them into cans at once or lose them.

The operation of commercial canning consists of the following steps, and in general applies to about all the fruits and vegetables used:

1 Preparation of the material for canning, such as sorting out the spoiled, washing and trimming
2 Packing into cans, either by hand or machine
3 Adding the necessary juice, likewise by hand or machine
4 Exhausting, or reducing the pressure within the can
5 Sealing either by the old method of soldering the top or by the new so-called sanitary method by which the top is pneumatically crimped on to the can
6 Sterilizing by heat in continuous or non-continuous retorts; and
7 Inspecting the cans for imperfect sealing, then labeling, boxing and shipping.

Procedure Followed in Tomato Canning

As applied to tomato canning, the above procedure operates as follows: Tomatoes in the Tri-State District (Maryland, Delaware, New Jersey) are usually shipped either by boat, car or wagon in what is known as the ⅝-bu. basket, stacked, and piled several high at the destination. About the only advantage this method of shipping possesses is that the baskets are easily handled, are light and when stacked afford ventilation through the pile, thus reducing the inevitable spoilage to a minimum.

The tomatoes are then dumped into a scalder at the rate of about twenty baskets per minute, more or less, according to size and condition of tomatoes and rate at which they are used by peelers. This machine washes the fruit and by means of a continuous chain belt carries it through a jet of live steam, then quickly under a curtain of cold water. The short duration of the steam application localizes the heat mostly at the skin, while the sudden bath in comparatively cold water cracks the skin, thus rendering the latter easy to be removed. The procedure from here differs somewhat, but the essential point is that the scalded fruit is then dumped from the scalder belt into shallow pans or other receptacles which travel along a table provided with a moving belt about which are stationed the women who peel. As the latter are in need of tomatoes they slide the basket or pan of tomatoes from the moving belt on to a small shelf in front of them, peel the tomatoes over a trough or pan, and place the peeled fruit into a bucket. Sometimes tomatoes are brought to them and dumped into a stationary receptacle out of which the peeling is done. When the bucket of peeled tomatoes is full, the peeler is paid on the spot and is directed to place her bucket of tomatoes on the same or another belt, according to the system used. The peeled tomatoes are thus carried to the filling machines. In some factories the tomatoes are placed on a long table around which stand the girls who pack them into the cans by weight. In other cases the tomatoes are dumped into filling machines set to deliver a so-called constant quantity of the fruit into cans automatically placed to receive it, and in the same way carried away when filled.

[1] Chemical Technologist, Bureau of Plant Industry, Drug and Poisonous Plant Investigations.

The cans containing solid, comparatively speaking dry or drained tomatoes are then delivered to belts which convey them to machines where they are filled with tomato juice even with the top. This juice is collected from the receptacles of tomatoes, for after peeling the fruit loses juice continually all along the line until canned. Then the cans pass into the exhaust box.

The object of exhausting is to heat the contents of the can to a slightly elevated temperature so that when capped and cooled to atmospheric temperature the contraction of the contents causes a slight diminution in pressure. This is called exhausting. This heating is effected by live-steam jets and may last several minutes, depending upon the condition of the fruit, duration of contact, intensity of heating and quality sought.

From this box the cans are capped. If the old soldering process is used, the cans pass under a machine which washes off the top. A cap is placed over the hole by a girl and is soldered either by hand or by a machine. In the newer or so-called sanitary method the can passes directly from the exhaust box to the closing machine which sets the top on and crimps it pneumatically to the flange of the can.

Since tomatoes may be sterilized by heating to either 212 deg. fahr. for, say, 30 min., or 240 deg. for 10 min., it follows that in the first case an open tank of boiling water is sufficient, while in the latter event a closed retort similar to the autoclave of the bacteriological laboratory may be used.

After this treatment, called processing, the goods are stacked on the floor long enough to enable all faulty cans to manifest themselves, which they do in a manner never to be forgotten by any one who ever passes through a factory where they are stored! They are then labeled by hand or machine, boxed and shipped.

Sources of Loss in Tomato Packing

All of this sounds as if the packer's whole effort is to start the operation and all will then go well. The starting is the easiest of all. To maintain the pace and yet pack with a minimum of waste and lost motion is the important problem. Great as have been the strides in developing the art of canning, we have not half covered the ground from the standpoint of avoiding waste of material, not to mention the almost criminal waste of heat.

If the pack represents 50 per cent of the weight of the original raw stock, the packer congratulates himself on the successful yield. Sometimes it yields 65 per cent. Often it is down in the thirties. This means that if we take a 50 per cent yield as our basis, in Maryland we lose 71,000,000 cans or over $2,000,000 at $15 per ton of raw tomatoes, and in the United States 785,000,000 cans, or nearly $5,500,000.

The first place where good engineering practice is necessary is in the devising of an efficient sorting table. This is the tomato conveyor belt along the sides of which stand the women who pick out the unsound material. The object sought is a procedure whereby the unsound fruit can be detected without picking up each individual tomato to inspect the condition of the underside, and at the same time too rough treatment of the delicate fruit be avoided. Since much of the fruit is very ripe and all of it very juicy, any rough treatment will crack it, resulting in loss of juice and deterioration of quality. Efficient sorting consists in inspection of the whole tomato with ready means of removal and disposal of the unsound ones. Machines which rotate the tomato tend to crush the soft goods; spraying machines with strong sprays designed to dig out the decayed portions of the fruit, operate to destroy sound but at the same time very ripe stock; while plane belts equipped with ridges over which the tomatoes will tumble either do not work in a jam or contribute to shrinkage by cracking soft fruit.

The greatest actual loss occurs in the operation of peeling. Now give a woman time and she can doubtless peel a tomato with but little loss over that naturally expected due to core and juice. But if she is doing piece work and is paid by the basket, is not charged with the raw material and does not pay for the waste, then she ruthlessly cuts away much of the tomato in her haste and the packer pays double.

A 50 per cent yield is fair and one of 65 per cent extraordinary. The rest is absolute waste. The solid part is hauled away at a net loss; the juice, containing as much food and condiment value as the so-called solid portions, flows into the sewer. And we cry, "Increase the tomato acreage."

Another source of loss is the tomato filling machine. Imagine the effect on a tomato when it is forced up into a cylinder closed at one end by a piston and discharged through the small top into the can by the descending piston. To say the least the tomato is badly torn and the valuable juice flows away. Other types of fillers exist but each has its serious objections; most all of them not only tear the fruit more or less, but give unequal fills of the so-called solid matter by their inability to prevent the liquid portions from settling to the bottom of the hopper and leaving the upper ones dry. This is largely why the housewife complains that often she opens a can and finds it mostly juice with here and there a lonely piece of tomato. Of course, hand filling obviates such factors contributing to loss of quality as well as the very material one of loss of juice, but up goes the cost of packing!

The cans varying from half-full to overflowing of drained solids go to the juice filler. This is kept full of hot tomato juice and fills the can with juice even with the top. As explained above, this juice is from the drained fruit after peeling. It contains just as much food and condimental value as the more solid portion of the tomato and hence should be incorporated into the pack as an integral part of it. No machine has been invented which will fill a can to within a given distance from the top. If the tomato filler is working satisfactorily, from 5 to 10 per cent of juice is necessary to give the can a correct fill. If the filler gets out of adjustment due to a sudden change in the quality of the stock, or if the hopper is delivering too large a quantity of juice from the tomatoes crushed by the weight of those above, then the can comes through half-full of tomatoes. But the unthinking juice machine fills up the can with juice and we have another case of a watery looking pack. The top cannot be soldered on or crimped on to an absolutely full can. Provision is made by a dumper or other spilling device whereby this excess of juice is removed, leaving the level of the contents of the can approximately constant. Loss here may amount to as much as 15 per cent of the contents of the can.

The legitimate skin, core and seed waste amounts to about 5 per cent of the original tomato. The yield of goods in cans is 50 per cent, leaving a net loss of about 45 per cent. Almost all of this can be recovered and will amount to more than twice what the Government has commandeered to feed an army.

Manufacture of Concentrated Tomato Products

Wastes are not the only phases of tomato packing commanding the attention of engineers. Several other lines of tomato manufacture have been opened up involving engineering questions which are of moment not only to this industry but to

several others. This is the manufacture of the more or less concentrated products of pulped tomatoes used in soup and ketchup. Tomatoes are pulped in commercial practice by more or less disintegrating them either by crushing or a slight cooking, and passing them continuously into what is known as a "cyclone" machine (described later on) which separates the skin, seed and core from the juice and flesh of the tomato. A mixture of flesh and juice passes through together while seed, skin and cores are discarded as waste. This mixture of juice and disintegrated flesh is called cyclone juice and differs only from what is known as tomato pulp in the fact that it is not concentrated. This concentration of cyclone juice to the various pulps, sauces and pastes is an engineering problem pure and simple, and its successful operation can only be attained by applying engineering methods.

Concentration of tomato cyclone juice is effected by boiling out the water. It is this boiling that presents such problems to the industry. When one considers that the market value of the product depends on its thickness and color, he can realize that the factors determining quality militate against each other. Thus, to overcome this darkening by heat is the great problem. Since this is doubtless due to a chemical reaction, it possesses the factors of temperature and time. In other words, if we cook the juice quick enough or at a low enough temperature, good results may be effected. Vacuum evaporation secures the latter and gives a splendid product.

But this operation applied to tomato products does not present the simplicity of evaporation in vacuo of homogeneous liquors such as sugar syrups. Excessive foaming, caking in the beating surfaces of the pulpy fibrous mass, introducing the flavoring ingredients and handling the more or less pasty finished mass, all present problems which only recently have been satisfactorily handled by engineers.

Many tomato-pulping plants are not able to install the expensive equipment for vacuum evaporation or maintain the skilled service necessary for its control. To meet this demand engineers have endeavored to effect evaporation by several methods, all seeking to expose the rich and fibrous material to the action of air and temperature for as short a period as possible. Continuous evaporation, forced draft applied to ordinary steam-jacket kettles whereby dry air is continually removing the saturated air over the boiling mass, evaporating machines incorporating a rapid stirring of a small amount of juice exposed to a large heating surface for a brief interval, mechanical separation of fiber from the clear, colorless juice with high concentration of the latter, and then addition and mixing of the uncooked fiber to it, and boiling in wooden tanks with closed steam coils to insure absence of metallic contamination together with rapid boil, are all now being tried out.

Continuous evaporators seek to minimize labor but require careful control to secure a product of uniform consistency. I know of none on the market simple in construction and which operate more efficiently than an ordinary steam-jacket kettle.

Another large problem necessary to be solved is a method for storing and holding cheaply large quantities of tomatoes. As stated previously, the packer buys pretty closely up to his capacity, but the uncertainty accompanying transportation often results in a glut. This means either a driving of the factory to use up the goods or great loss from spoilage, usually both. In the Middle West some firms use a large tank of water into which the tomatoes are dumped. Others spray the piles of tomatoes in baskets or crates, while many merely stack them loosely to insure good ventilation. But to be a success the method developed must be considered in the light of the fact that the canned-tomato industry is widely distributed over the country, is composed of a large number of small plants, some near water and some not, and is not an industry operated by a very high class of labor.

Tomato Paste a Product That Cuts Waste Fifty Per Cent

That the tomato industry is a fertile field for the application of economies in operation is evidenced by the development of a tomato product which contains all the food and condimental value of the tomato, reduces loss from 50 per cent to 5 per cent and produces a product which can be sold for about one-half of the price of the regular canned tomato, figured on the basis of equal content of raw material. I refer to the tomato-paste industry.

In the manufacture of this product, tomatoes pass through large washing machines, then over sorting belts where the unsound material is picked out by hand, thence into a crusher and immediately into the previously mentioned cyclone machines. These consist of horizontal perforated metallic cylinders slightly open at each end, about two feet in diameter and three or four feet long, provided with a paddle rotating on the axis of the cylinder and barely escaping the sides. The violent beating of this paddle forces the juice and flesh of the tomato through the perforations while the seed, skin and cores, deprived of their juice, pass out through a small gate at one end of the cylinder. This dry material, comprising about 5 per cent of the original tomato, is called cyclone waste, and will be referred to again.

The juicy mass of liquor and ground tomato flesh from the cyclone perforations is called in the trade "cyclone juice," as distinguished from the more or less clear, watery looking liquid in the tomato which is familiar to all. This cyclone juice is then concentrated in the proportion of about 5 or 6 to 7, according to the character of the raw stock and the quality of the finished product. This industry, while a subsidiary of that of the whole tomato, has developed quite a respectable technology of its own in which is a splendid field for good engineering practice.

For instance, the market value of the finished pasty mass, called tomato paste, is proportional to the bright red color; the freshness of the tomato flavor, and the thickness, and, as stated previously, the ordinary concentrating methods of evaporation serve to destroy color and taste, while pastiness renders it difficult to handle in the kettles without burning or to transfer from the kettles to the fillers. To save color we are inclined to sacrifice pastiness (concentrate loss); to make it thicker and thus put more tomato in a can, there is a tendency to sacrifice color, taste and ease of operation.

Economies Now Obtained

Thanks to the prodding of necessity, these baneful effects have been minimized by adopting more efficient means of evaporation both at atmospheric pressure and in vacuo, while the handling of the pasty mass likewise has now reached a state of satisfactory development. Overcoming difficulties of concentration and handling, together with mechanical applications as substitutes for the hand labor of the ordinary peeling processes, is an eloquent example of the potentialities in engineering practice as it may be applied to food problems. This development cuts down the labor necessary to handle about 5000 baskets per day from somewhere near 140 persons to about 35, reduces the tomato waste from about 50 per cent to about 5 per cent, eliminates all waste to the consumer by giving him a product free from seeds and cores, saves tin plate by using a can containing 30 sq. in. in comparison with one containing 91 sq. in., reduces shipping cost from the fact that the standard paste can contains 6 oz. net weight while

the can of standard tomatoes of equal weight of tomato solids contains 32 oz. net weight, and at the same time materially lessens storage and conserves transportation space. This tomato-paste manufacture of course puts the goods in a form somewhat different from that with which the housewife is familiar, but a publicity campaign should demonstrate to the intelligent housewife that not only is she effecting a direct saving of 50 per cent of her bill for tomatoes, but also indirectly in that by this means she is enabling what is now waste to be utilized for other food purposes, directly as edible fat (oil) and cattle food (press cake).

But if we again apply economies in operation we find that even this 5 per cent of cyclone waste can be utilized. As stated above, it consists of the comparatively speaking dry cores, skins and seeds of the pulped tomatoes in the proportion of about two-thirds wet skins and cores, water, and one-third wet seed. These seeds contain a valuable edible oil which closely resembles olive oil, in fact, so much so that in Italy it has been largely used for the adulteration of olive oil. The press cake remaining after removal of the oil is valuable for stock feed. Inasmuch as the cake is ground up for this use, the skins can be ground in with it, thus insuring absolutely no loss, and rendering all of the tomato entering the plant a valuable commercial commodity.

The Industry in Need of Engineering Direction

Thus we see that simple as tomato packing seems to be, it is, notwithstanding, an industry in great need of development. It has grown to huge proportions in volume of business, but has not developed in the mechanical end at all commensurate. Thanks to the operation of the Food and Drugs Act, and the meritorious activities of the state inspection and control service, the industry has been raised from one of indifferent sanitation to a high state of excellence. But until men trained in engineering take hold of the problems awaiting solution, the industry will continue to blunder on and develop under the guidance of men whose whole engineering viewpoint is circumscribed by the narrow confines of their own establishments. Wastes await reclamation, factory procedure needs the application of approved engineering knowledge, and the time-worn practices of forty years need to be revised in the light of applied science.

TEMPERATURES AND THEIR DURATION DURING THE HEATING SEASON

By REGINALD PELHAM BOLTON, NEW YORK, N. Y.

THE unusual e treme of low temperatures which particularly affected the City of New York during the heating season of 1917-1918 invites careful study as to the effect of similar possible occurrences upon the installations of apparatus designed to effect the heating of buildings. The prevalence of extremely low temperatures in the vicinity of New York City is very limited as regards time, and the writer has pointed out on previous occasions that the existence of a temperature below zero has not usually prevailed beyond the early hours of the morning, but is followed by a sharply rising temperature about sunrise, and has rarely been at zero in the working hours of the day. In December 1917 and January 1918 such low temperatures were maintained, on some occasions, all day, with great inconvenience and suffering, due to the incapacity of heating apparatus to meet such a condition.

The length of time during which any given temperature below 70 deg. may prevail during a season affords an interesting comparative study, and a summary of the figures recorded by the Meteorological Observatory in the City of New York is presented in Figs. 1-3, in which the temperatures are inverted on the vertical scale, and the period of time is shown on the horizontal scale. Fig. 1 is the record of the season of 1904-1905; Fig. 2 that of 1913-1914; and Fig. 3 that of 1917-1918.

An examination of the mean temperatures recorded during the past 49 years shows that the average was 40.4 deg. This may be compared with the extreme low temperatures of the past heating season, the average of which was 37.66 deg. Compared by months, the average temperatures were as given in Table 1. It may be observed from this that at the end of the last season the average monthly temperatures were higher than usual.

Another interesting point which may be observed is that the temperature of 32 deg. and below was maintained in the past cold season about 35 per cent of the time of the season, which is very similar to that in Fig. 1, representing an average condition.

Reference to Fig. 2 shows that during about 50 per cent of the whole season the temperature ranged between 50 and 30 deg., and for about 25 per cent of the season the temperature was above 50 deg.; while in Fig. 3 the period during which

TABLE 1 COMPARISON OF AVERAGE TEMPERATURES (DEG. FAHR.) DURING THE HEATING SEASON

	Mean, 49 Years	Season of 1917-1918
October	55.6	52.6
November	44.1	41.4
December	34.2	25.0
January	31.2	21.5
February	30.5	30.7
March	37.5	41.6
April	49.1	50.1

temperatures of 50 deg. and excess prevailed was not much more than 22 per cent.

It has generally been assumed that the lowest temperature for which provision must be made in heating the buildings of New York City is that of zero, and consequently the capacity of boilers or of heating apparatus is usually installed upon that basis. Reference to these diagrams indicates the extent to which the capacity of the heating apparatus or boilers is utilized, both as regards output and time, and the relatively insignificant period during which the lowest temperatures prevail. It is for this comparatively minute demand that a large part of the investment in boilers and heating systems is necessarily installed, and the relative expense of providing for this extra heating capacity seems disproportionate to the results achieved. Thus it will be seen that in the season of 1904-1905, which was one fairly representative of average conditions, the percentage of the season, when the temperature was 10 deg. or less, was only 0.8 per cent, yet it will be evident that at least one-seventh of the entire investment in boilers and heating apparatus

had been provided for use in this quite insignificant period of time.

In the season of the year 1913-1914 (Fig. 2), in which unusually low temperatures prevailed, and which was perhaps our coldest recorded season prior to last year, the period of

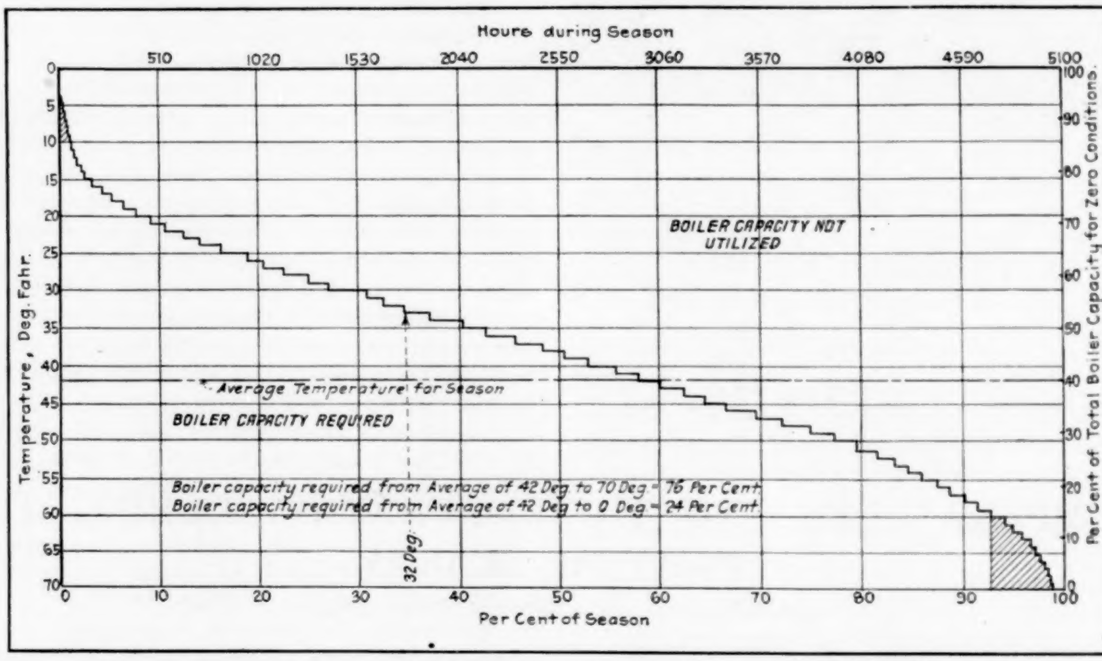

FIG. 1 TEMPERATURES AND PERIODS DURING HEATING SEASON OF 1904-1905, MANHATTAN

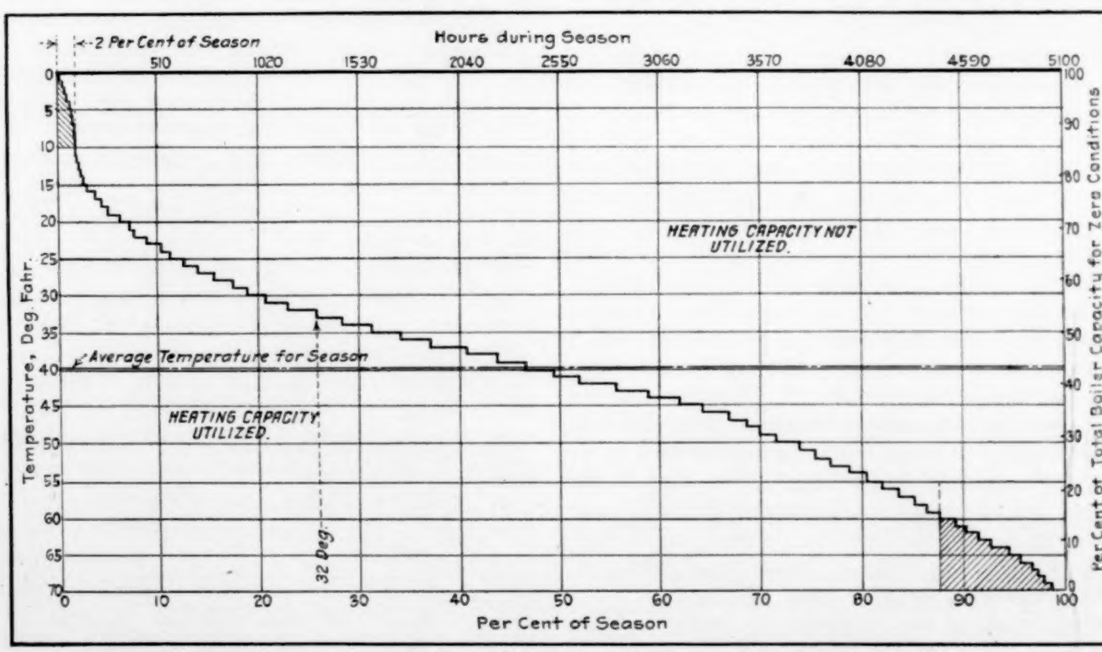

FIG. 2 TEMPERATURES AND PERIODS DURING HEATING SEASON OF 1913-1914, MANHATTAN

time during which the temperature of 10 deg. or less was in existence, was only 2.1 per cent of the heating season, as shown by the shaded space at the upper left-hand corner of the diagram.

During the past extremely cold winter (Fig. 3), when our temperatures descended as low as 12 deg. below zero, this proportion of the season during which the temperature was 10 deg. or less was only 4.8 per cent. It would thus seem that the use which is made of the extra capacity of our heating installation is not in excess of 5 per cent of the total period of the heating season. This leads to some consideration as to whether other means could not be found which would relieve the owners of property of the investment in a large amount of expensive apparatus so unprofitably utilized, and indicates a direction in which the ingenuity of the heating engineers of the country might very well be applied, to the advantage of all concerned.

It is possible that if some means for the substitution of gas or electricity as an auxiliary heating agent could be introduced at less expense for installation than the usual boilers, piping and radiators, it would be profitable to make use of those supplies of heat, even at prices greatly in excess of the actual cost of producing steam or hot water.

As a matter of fact, much fuel is wasted by overheating residences and apartments at times when the exterior temperature is above 60 deg. If auxiliary gas or electric appliances were

installed the use of steam might in some buildings be discontinued when the temperature rose above 60 deg., which even in the past cold season was the case during 295 hours, or about 6 per cent of the total.

The subject has acquired a certain aspect of necessity, since the past winter disclosed the fact that there may upon occasions occur temperatures falling substantially below zero, and prevailing for many hours at a time. For such conditions it may be said there are but few installations of heating apparatus in New York City proportioned to provide the necessary heating capacity. Boilers may indeed be forced to deliver additional output, but radiators and piping are not capable of relative increase to meet a condition such as that which prevailed during last winter on several occasions.

To add to heating apparatus for the purpose of meeting this contingency, so limited in period of time and yet so urgent in character, would involve enormous expense. The situation was met only to an inadequate extent last winter by the purchase and use of a multitude of oil heaters, electric heaters, gas radiators, and the wasteful burning of gas in flame burners, kitchen ranges and gas logs.

Looking at the other end of the scale of time and temperatures, as shown in these diagrams, we find another period of time during which such auxiliary apparatus might be utilized. It is that during which temperatures of 60 deg. and above prevail.

In the season of 1904-1905 such temperatures were in existence for upward of 400 hours, or 8 per cent of the season, during which time the capacity of an installation proportioned on heating at zero was utilized to an extent of less than 15 per cent. It would seem that during such a period economic use might be made of whatever auxiliary appliances and methods of supply of heat were provided to meet the excess conditions required during extremely low temperatures at the upper end of the diagram.

It is interesting also to note in this connection that during an average season, such as that of 1904-1905, the entire use which is made of the installed capacity of heating apparatus is only 24 per cent, up to the average temperature of 42 deg., while the capacity in use above that temperature to the limit of 70 deg. is 76 per cent. This again indicates the relatively expensive provision required to be made to maintain the temperature of our buildings during the prevalence of the lower temperatures of the season.

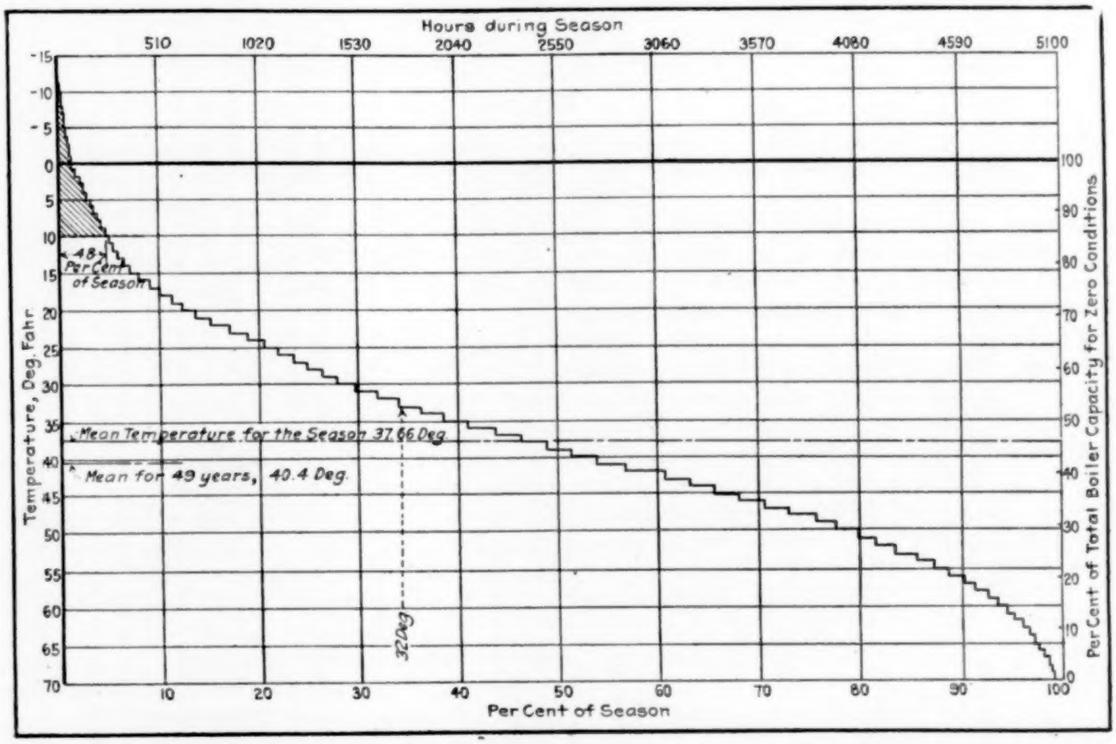

Fig. 3 Temperatures and Their Duration, Heating Season of 1917-1918, New York City

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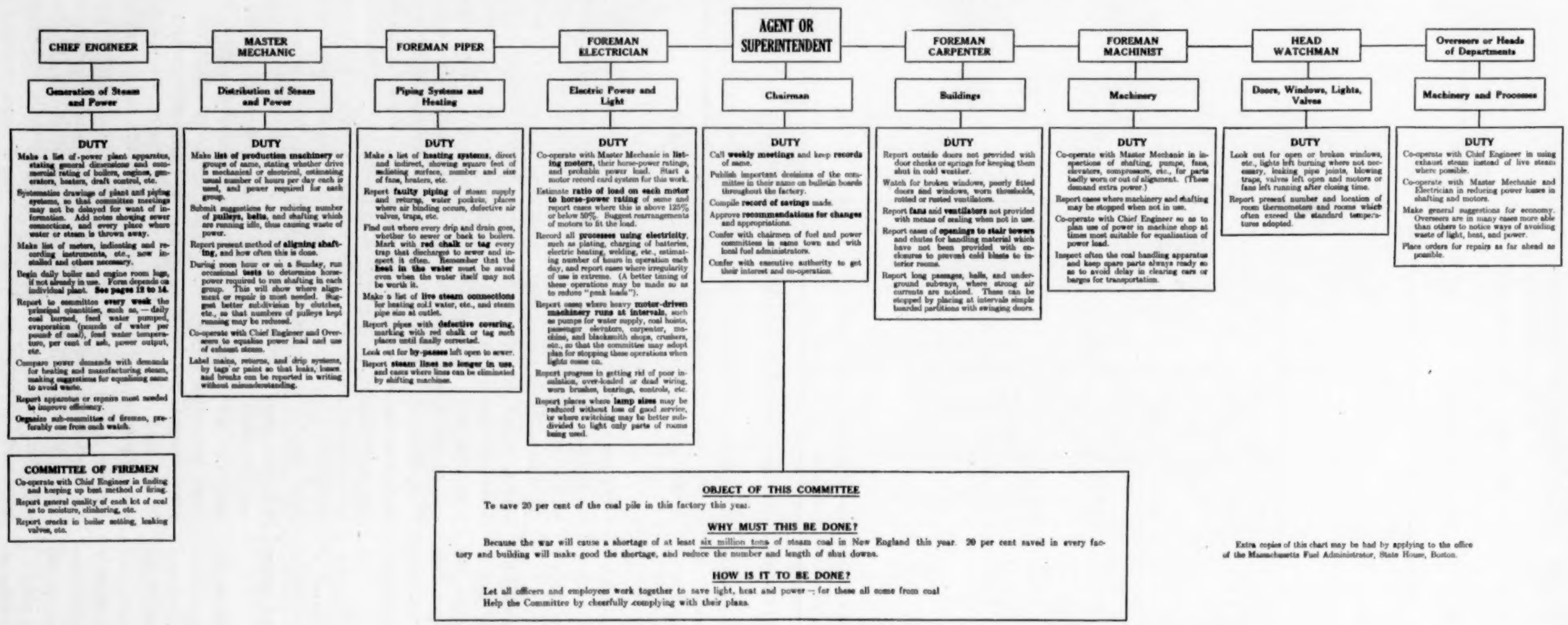
Owing to the enormous increase of Government war work, the governmental departments at Washington are being flooded with letters of inquiry on every conceivable subject concerning the war, and it has been found a physical impossibility for the clerks, though they number an army in themselves now, to give many of these letters proper attention and reply. There is published daily at Washington, under authority and by direction of the President, a Government newspaper—*the Official U. S. Bulletin.* This newspaper prints every day all the more important rulings, decisions, proclamations, orders, etc., as they are promulgated by the several departments and the many special committees and agencies now in operation at the National Capital. This official journal is posted daily in every post office in the United States, more than 56,000 in number, and may also be found on file at all libraries, boards of trade and chambers of commerce, the offices of mayors, governors and other state and federal officials. By consulting these files most questions will be found readily answered; there will be little necessity for letter writing; the unnecessary congestion of the mails will be appreciably relieved; the railroads will be called upon to use fewer correspondence sacks and the mass of business that is piling up in the Government departments will be eased considerably. Hundreds of clerks, now answering correspondence, will be enabled to give their time to essentially important work, and a fundamentally patriotic service will have been performed by the public.

FACTORY FUEL AND POWER COMMITTEE — ORGANIZATION CHART



Bulletin of Advisory Engineering Committee of Massachusetts Fuel Administration

The Society's membership is taking an active part in the various states in the conservation of fuel. In Massachusetts, the Advisory Engineering Committee, appointed by James J. Storrow, Massachusetts Fuel Administrator, consists of seven members, of whom six are members of this Society, as follows: Ira N. Hollis, *Chairman*, 11 Boynton Street, Worcester; Charles T. Main, 201 Devonshire St., Boston; William G. Starkweather, 53 State Street, Boston; George P. Gilmore, 46 Dudley Street, Fall River; Arthur T. Safford, 66 Broadway, Lowell; Joseph A. Skinner, Holyoke, and Thomas Hawley (non-member), 115 Huntington Avenue, Boston.

This committee has just issued a report specifically for use in Massachusetts, but which, as expressed by one fuel engineer, "would be an admirable report for the whole 'United States,' if these two words were substituted on the cover for the word 'Massachusetts.'" The report is known as Bulletin No. 1 and deals concisely with the following subjects:

1 Necessity for reduction of demand for coal by all users.

2 Methods for saving coal, including a discussion of general principles and the special conditions to be met in mills, factories, shops and power stations, including consideration both of central stations and purchased power. Detailed suggestions are further given for the boiler room, the engine room, manufacturing processes, heating of shops and work rooms, the lighting system and the power-transmission system.

3 Methods for saving coal in business and apartment buildings, hotels, schools, churches and public buildings.

4 Methods of saving coal in residences and smaller public buildings.

The bulletin concludes with forms for daily boiler-room and engine-room records and power-station reports. Its distinctive feature is the information given regarding the Massachusetts plan, which has been successfully tried out and is now recommended for universal adoption for the organization in each plant of a Fuel and Power Committee composed of employees of the company, whose duty it is to see that fuel is burned economically, and of even more importance, to prevent the waste of steam and power after the heat or power have been generated. This affords a means for coöperation, and it is felt to be imperative that all district fuel committees should see that the industries coming within their reach are so organized. In fact, it has been proposed that the delivery of coal should be conditional upon such organization.

In order to clearly outline the functions and scope of such a Fuel and Power Committee, the report publishes an organization chart which is reproduced herewith for the benefit of other communities, as well as those in Massachusetts. The chart is so clearly arranged that no further explanation is necessary.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Second Law of Thermodynamics

To the Editor:

Mr. Okey's letter published on page 467 of the June number of The Journal brings another instance of the periodic outcropping of misunderstanding of the "Second Law of Thermodynamics." This misunderstanding may be as much the fault of the teachers of thermodynamics as of the pupils, but in either case the widespread confusion of mind is deplorable.

First, as to Mr. Okey's "operative" apparatus, this constitutes no infraction of the Second Law. It develops its power quite normally from the heat flowing from the warmer body (the air surrounding the boiler) to the colder one (the air chilled by atmospheric evaporation) quite as any heat engine develops power from fuel heat flowing to refrigerator. Air is everywhere being chilled by atmospheric evaporation; but it has to be warmed first by sun heat before it can do it. If Mr. Okey's turbine had not been interposed, the atmospheric evaporation would have chilled the air surrounding his boiler just the same.

This is exactly as all the sun heat reaching this earth eventually must re-radiate into space. If the process be temporarily interrupted by the storage of the heat in coal beds, with the incidental driving of human engines before it is allowed to escape to refrigeration, it is not altered thereby. The Second Law holds at every point.

The trouble in Mr. Okey's case does not lie in his apparatus, but in his explanation of it. His confusion of mind arises from the fact that he has been told that heat is convertible into work, and that our prime movers are "heat engines." They are not. There is no such thing, in careful phrase. They are all "temperature engines." The basic laws explaining these statements follow.

Every form of energy is partially convertible into every other form of energy, with conservation of quantities. This is, in reality, the proper statement of the "First Law" of thermodynamics. The transformation of heat into work is merely one instance of this general law, which runs through all fields of energetics.

No form of energy is wholly convertible into any other form. This is a basic law of energetics as important as either the so-called "First" or "Second" laws. Yet, so far as the writer is aware, it nowhere finds expression in the textbooks of thermodynamics. It should be called the Second Law, and what is now called the Second be made the Third.

Each form of energy is convertible into any other *only to the degree that range in its intensity factor (in the case of heat—temperature) exists in the environment.* This is, in reality, the general statement of the so-called "Second Law," preferably to be called the Third, in a form applying directly to problems in energy transformation. Of this law the limitation to "heat engines"—and the thing which proves that they should be called "temperature engines" is the basic formula: $(T_1 - T_2)/T_1$—is merely a single instance. We have not yet acquired any foundation for computing efficiencies nor for comprehending actions until we have the significance of this cosmic law well in mind.

None of these laws constitutes any denial of the possibility of deriving work from the heat of the atmosphere. The earth's atmosphere, particularly near the earth's surface, is relatively a quite warm thing, heated by sun heat. Wherever may be found a spot colder than the local atmosphere—in the sea, on the mountain tops, in the upper atmosphere, etc.—there many a means for the development of power by the connection and interaction of the two places may be devised. Not one of these devices would give any surprise to the thermodynamicist, because none would infringe the basic laws against thermodynamic perpetual motion.

This frequent evidence of confusion of mind regarding the fundamental principles underlying the transformation of energy—one of the most widespread fields of applied science—is ground for deep regret that not even a single technical school boasts a chair in *Energetics*, teaching pure mechanics, thermodynamics, electrical and chemical energetics simultaneously, as one subject.

Sidney A. Reeve.

New York, N. Y.

To the Editor:

I have been greatly interested in Mr. Okey's very ingenious little fallacy regarding the second law of thermodynamics in the June number of The Journal.

It is possible that you already have had many much better explanations of the situation than I can offer.

In the first place, I would like to compliment Mr. Okey on the entire arrangement. It is not often in these days that any new thermodynamic system is originated. Mr. Okey has set forth what seems to me to be quite a novelty, and has carried it out in a very ingenious way. I hope to be able to inspect the original apparatus before a great while.

The only point to which I take exception is the statement that the second law of thermodynamics is violated. This is not the case.

In order to completely understand the matter, we must include with the apparatus such part of the atmospheric action as will make a complete closed cycle.

This is that portion of the room which will take away the water vapor from the SO_2 condenser and return condensed water. We can do this without destroying Mr. Okey's principles in the least. Suppose that there is a closed chamber surrounding the SO_2 condenser as shown in Fig. 1, in which the parts which are added are shown in dotted lines. This chamber takes the water vapor which is evaporated, and by extracting heat from it, by contact with the coldest of the surrounding bodies, condenses the water, which is then returned to be re-evaporated.

There will be a certain constant pressure in the added chamber. The saturation temperature corresponding to this will be the temperature at which heat is taken away in the cycle, and will be the lower temperature of the second law of thermo-

dynamics. The upper temperature is of course the temperature at which heat is added in the SO_2 boiler.

I think it will be found that the completed apparatus is

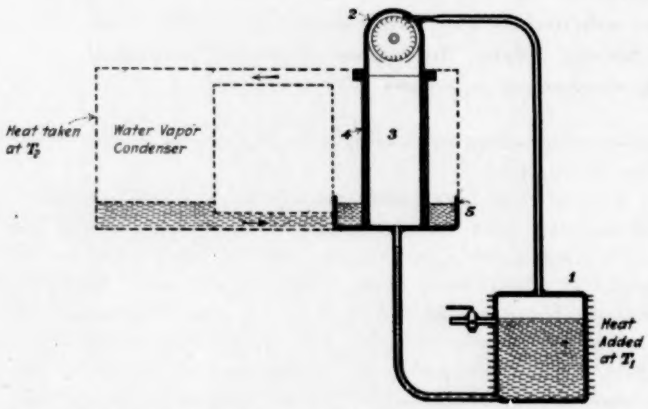


Fig. 1 Modified Form of Okey Apparatus for Obtaining Mechanical Work from the Heat in the Air

entirely consistent with the second law. It forms, in fact, a binary-vapor cycle, exactly identical with some such cycles which have already been fully worked out.

S. A. Moss.

West Lynn, Mass.

Committee on Development Proposed

To the Editor:

Referring to the A.S.C.E. resolutions creating a Committee on Development [see p. 712—Editor], I cannot help but feel that a most important and timely step has been taken by the Civil Engineers. The social, industrial and economic changes to which the preamble properly calls attention have been the result of a development with which the engineer has been more closely associated than any other profession or group. Therefore they demand our earnest and constant study, and in the opinion of many they necessitate a readjustment and a restatement of the aims of our various engineering societies.

Another problem requiring an early solution is the organization of all engineering societies, national and local, in such a manner as to harmonize and coördinate their efforts toward promoting the interests of the engineering profession and serving the community. It may be said—I believe without danger of contradiction—that the principal aims of all the engineering societies, according to the conception of their membership, are more or less identical (although expressed in various ways), and that the points of difference relate to professional and geographical limitations. Organization must therefore look toward joint action where the aims are general and identical and toward separate action where aims are specific and individual. In view of the magnitude of such an organization, however, and in view of the difference in structure and in scope of the many units to be coördinated, a plan for coöperation must be preceded by thorough discussion and clear statement of the present-day aims of the units to be combined.

These considerations make me feel that our Society should take up at the earliest possible time a broad and thorough examination of its aims, and that such examination would best be coincident with similar action in other national, and preferably also local, engineering societies. Previous attempts and discussions in our Society have not carried us very far, largely, I believe, because they have not been sufficiently general. May I suggest, therefore, that a committee of our Society similar to that of the A. S. C. E. might be of incalculable benefit just at this time, and that pressure upon other national societies, also to follow the lead of the A. S. C. E., would be appropriate. If constituted along the lines indicated in the resolutions referred to, i. e., composed mostly of section representatives, such committees of national societies could not help but spread the interest and discussion of this vital subject to every city, town and hamlet of the country where engineers are found.

If a committee as suggested were soon appointed, a report could no doubt be submitted to the Council previous to the Annual Meeting in December, so that a general discussion on the part of the whole Society could then take place.

Louis C. Marburg.

Philadelphia, Pa.

Economic Effects of Impurities in Coal

To the Editor:

In discussing the subject of low-grade fuels and impurities in coal at the Spring meeting, Mr. Pigott made the statement that the principal effect of burning a lower-grade coal in the boiler furnace was the reduction in boiler capacity. With coals from the Middle West there is a considerable decrease in efficiency as well, as with coals containing a high percentage of ash there is inevitably a greater ashpit loss than with better coals, and it should be borne in mind that while the average fireman can burn good coal economically with the proper equipment, it takes an exceptionally good man to burn poor coal so as to get the most out of it. In this connection the cost of handling the excess ash and moisture in the coal should be considered as well as the disposition of the increased amount of refuse from the furnace; further, with poor grades of coal increased capacity can be obtained only with increased ashpit loss, and under ordinary conditions and variations of coal it is extremely difficult to determine the most economical point of operating.

In order to obtain the required capacity for peaks some of the companies who have experienced considerable difficulty in obtaining good coal have made it a practice to purchase only enough good coal to carry them over the peaks, as it is possible to get along during off-peak periods with the lower grades of fuel, which are cheaper and more easily obtainable. This good coal is segregated so that it can be distributed to the boilers by hand or by special equipment during the peak periods, after which the boiler rooms return to their regular operation as soon as possible with the coal ordinarily received.

Alex D. Bailey.

Chicago, Ill.

"The Wonder Ship of the World" was launched at the Bethlehem Shipbuilding Corporation, Union Plant, Alameda, when the *Defiance*, a 12,000-tonner, slid off the ways just 38 calendar days from the laying of the keel.

Director-General Schwab called the *Defiance* the "Wonder Ship." Mr. Schwab declared that the building of this boat in 38 days, including Sundays and holidays, really is the most remarkable performance in shipbuilding history. On a basis of tons of steel fabricated into the vessel daily, the building of the *Defiance* was about 30 per cent better than the *Tuckahoe*, the 27-day ship built by the New York Shipbuilding Corporation. This comparison is not absolutely accurate, but it is considered fair. (*Emergency Fleet News*, vol. 1, no. 19, July 11, 1918, p. 16)

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

PRESIDENT MAIN said that "it was number 7" when the latest member of his personal staff left for War Work. This, in addition to his personal devotion to the service of the Government to the exclusion almost of his own business, will explain, if explanations are necessary, the earnestness with which the President has just appealed by letter to the membership for the services of every competent engineer in the country in the interest of the Government.

It is here that announcement should be made of the summons of the Committee on Emergency War Training to Mr. Ernest H. Hartford of the Society's Staff, to go to Washington and assist in the important work of organizing the Emergency War Training of technical men, throughout the United States. Forty thousand men are now being given an emergency training in the various schools and colleges and by the end of the year it is hoped to bring this number to one hundred thousand.

There is one feature relating to the appeal for enrollment of engineers for war service which requires explanation, namely: that while we are continuously furnishing names of men in response to specified requests by the different Bureaus of the Government, and the industries generally, only in rare cases are we able to reverse the operation and place a man anxious to serve. We have first to await the request, and the patience of such members is requested in this respect.

There is unfortunately small prospect, so far as we are able to judge, that the war will come to a speedy close, and in consequence thousands and even millions of men will probably be required. There is small doubt but that ample opportunity will eventually come to every one to contribute his services.

An interesting event in engineering circles which has come to our notice is the inauguration of the Engineering Institute of Canada, of which our esteemed member, Mr. H. H. Vaughan, is president. The intention of the Institute is to broaden the field of usefulness formerly covered by the Canadian Society of Civil Engineers, by uniting "all the Engineers in Canada, to whatever branch of the profession they may belong, into one Society."

We are just in receipt of the first number of their Journal, and it is of interest to know that it is uniform in size with our own JOURNAL, that is, nine inches by twelve. If any one doubted the wisdom of adopting this size, it would be well to observe that the nine-by-twelve size, which was determined upon by our Society a number of years ago, is used by a large proportion of the 1200 periodicals received in our Library from all portions of the world.

It will be the desire of this Society to coöperate with the Engineering Institute of Canada in all possible ways, and it may be that we can do this best by interchanging matter for the Engineering Survey and reviews of technical literature which we have developed; this is uniform with the practice of giving Engineering Survey material to the Research Information Committee of the National Research Council.

There is still further opportunity to coöperate in the matter of standards, President Vaughan having been appointed the Canadian representative on the British Engineering Standards Committee.

A noticeable feature of the policy of the Engineering Institute seems to be the emphasis placed upon sections and branches and the benefits to be obtained by participation of the Institute and also of each branch in matters of legislation. A conspicuous division of the Institute's committees comprises the legislative committees and there is besides a strong committee in each of the branches of the Institute throughout the Dominion. This is in keeping with the announcement of the object of the Institute, which is—

"To facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interests, to encourage original research, to develop and maintain high standards in the engineering profession and to enhance the usefulness of the profession to the public."

CALVIN W. RICE,
Secretary.

War Industries Readjustment Committee

THE National War Industries Readjustment Committee of the Society has been hard at work and has received numerous requests from manufacturers desiring to handle war orders. Government bureaus have been assisted in placing such orders. The Committee is anxious to learn of manufacturers who have an excess of work or whose production is lagging and would like to sublet part of their work.

For various reasons the output of war material is far below what it should be. Some of the main reasons are congested transportation, lack of material and lack of coördination. The purpose of our Committee is to do what it can to overcome such difficulties. To this end the Chairman, Mr. Parsons, has just returned from Washington, where he has been in conference with Messrs. George N. Peek and Charles A. Otis, of the War Industries Board. Mr. Otis is Chief of the Resources and Conversion Section, and has worked out a splendid regional plan with regional advisers as follows:

Bridgeport, B. D. Pierce, Jr., care Chamber of Commerce
New York, William Fellowes Morgan.
Philadelphia, Ernest T. Trigg, 322 Race St.
Pittsburgh, George S. Oliver, care Chamber of Commerce
Rochester, Esten A. Fletcher, care Chamber of Commerce
Cleveland, W. B. McAllister, care Chamber of Commerce
Detroit, Allan A. Templeton, Detroit Board of Commerce
Chicago, D. E. Felt, 29 So. LaSalle St.
Cincinnati, Edwin C. Gibbs, 31 East Fourth St.
Birmingham, T. H. Aldrich, 322 Brown-Marx Bldg.
Kansas City, F. D. Crabbs, care Chamber of Commerce
St. Louis, Jackson Johnson, care Chamber of Commerce
St. Paul, D. R. Cotton, care Chamber of Commerce
Milwaukee, August H. Vogel, Pfister & Vogel Leather Co.
Dallas, Louis Lipsitz, 407 Southland Life Bldg.
San Francisco, Frederick J. Koster, care Chamber of Commerce

Atlanta, Baltimore, Boston and Seattle appointments will be made very shortly.

The idea is that through this means it will be possible to place Government requirements in communities or regions, and expedite production through the coöperation of the various organizations and facilities within those regions. In order that our Society may do its utmost, it has been decided to coöperate in each of these regions. To this end President Main has appointed the following representatives to work with the above regional representatives of the War Industries Board in their several localities:

Bridgeport, Conn., Harry E. Harris, P. O. Box 852
New York City, G. K. Parsons, 29 Pine Street
Philadelphia, Pa., C. N. Lauer, care Day & Zimmerman
Pittsburgh, Pa., J. M. Graves, 435 Sixth Ave.
Rochester, N. Y., Ivar Lundgaard, 208 Culver Road
Cleveland, Ohio, F. H. Vose, 3203 Whitethorne Road, Euclid Heights
Detroit, Mich., G. W. Bissell, Mich. Agri. College, East Lansing, Mich.
Chicago, Ill., A. D. Bailey, 21 Elmwood Ave., La Grange, Ill.
Cincinnati, Ohio, Fred A. Geier, 2301 Grandview Ave., E.W.H.
Baltimore, Md., W. W. Varney, 710 North Carey St.
Atlanta, Ga., Robert Gregg, 960 Ponce de Leon
Birmingham, Ala., W. P. Caine, Ensley, Ala.
Kansas City, Mo., J. L. Harrington, Rockhill Manor
St. Louis, Mo., R. L. Radcliffe, 701 Laclede Gas Bldg.
Milwaukee, Wis., W. M. White, 747 Summit Ave.
Dallas, Tex., A. C. Scott, Scott Engineering Co.
San Francisco, Cal., B. F. Raber, 2027 Delaware St., Berkeley, Cal.
Seattle, Wash., R. M. Dyer, Puget Sound Bridge & Dredging Co.
Boston, Mass., A. C. Ashton, 33 Columbus Ave., Somerville, Mass.
St. Paul, Minn., Oliver Crosby.

It is the desire of the War Industries Board that our members act in an advisory capacity in the several regions. The reason for this is that our members being largely connected with industry are in the best position to advise regarding the feasibility of manufacturing, the interpretation of specifications, the adaptation of machines and processes, and the facilitation of production. In each of the regions there will be subcenters, and it will probably devolve upon our Society to be represented in each of these centers. It is likely that committees will be formed for specific technical and semi-technical questions, and our advice will be valuable in these committees. Further, it behooves us to be ready to fit in to the organization as it is developed by the War Industries Board.

The relation of our national War Industries Readjustment Committee to the several regional representatives of our Society will be that of the clearing house, supplying information and describing the methods which others are using, thus keeping our members informed of the best that is being done in other regions.

This Committee will be glad to answer inquiries and help in every way that it can to coördinate the activities of our representatives and the War Industries Board. The present headquarters of the Committee is in care of the Chairman, G. K. Parsons, President of the G. K. Parsons Corporation, 29 Pine Street, New York City.

Dr. Garfield to the Society

A letter of commendation has been received by President Main from Dr. Harry A. Garfield, U. S. Fuel Administrator, on the work accomplished by the Fuel Conservation Committee in preparing the Fuel Symposium for the Worcester Meeting of the Society, and for its use by the Publication Committee in THE JOURNAL. The letter is given below:

WASHINGTON, D. C.,
June 25, 1918.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS,
MR. CHARLES T. MAIN, President.

Dear Mr. Main:

Your Society is to be congratulated on its efforts for fuel conservation as set forth in this fuel-economy symposium. True Americanism calls for the most careful and efficient use of fuel—the driving force of war and industry.

Coal production, hand in hand with railroad service, has been increasing tremendously during recent weeks; but regardless of the supreme efforts being exerted, some parts of the country and some industries will have less coal than they want during the coming winter.

The demands of our great war machine are increasing hour by hour and they must be met. War requirements call for more coal, more raw materials of all kinds. Our transportation lines are clogged with the moving of the coal, of all the other raw materials and of the finished products.

Communities that have heeded the nation-wide warning to order early will be in far better position than those that have failed to heed the warning. War industries will be supplied. Other industries will receive coal and oil in proportion to their importance and the measure of their supply will depend on how faithfully everybody practices conservation.

Yours very truly,
(Signed) H. A. GARFIELD,
United States Fuel Administrator.

French Books Sent from the War Zone

The following is a letter which the Secretary has recently received from one of our members at the front, which gives an interesting personal note. The writer is a Canadian and was employed before enlisting in the capacity of assistant works manager in the Canada Machinery Corporation, Ltd., Galt, Ont. He is now in the 3d Brigade of the Canadian Field Artillery.

The books referred to have been received and placed in the library of the Society. Their titles are L'Essai des Combustibles, a translation of Fischer's Manual, and Résistance de Matériaux, by Ch. de Mussan.

DEAR MR. RICE:

Some time ago I sent you a couple of French textbooks which I picked up in the ruins of an engineering school. This school was evidently conducted by a mining association as an educational institution for the sons of miners. From scraps of drawings which were lying about, it must also have served as an engineering office for quite a large section of the mining area. At the time I found the books our brigade was in action in the town quite close to the place, and when things were quiet I used to dig around the building to break the monotony. One trip there I shall not forget, because Fritz opened up on the building while I was there and I am not a lover of flying bricks or steel. The place stands on a hill and as it is only a little over two miles from the enemy trenches, it is often used as a calibration point for his artillery.

I hope the books are of interest and some day I hope to be able to send you the pieces which I cut from the front pages showing the name of the town and school.

I wish there were time to write even a short synopsis of the work of the Canadian Field Artillery as I have seen it since January 1917. It is a most interesting branch of the service and especially during periods of open warfare. Sometimes the shelling around our positions is terrific and at other times there are quite long periods of comparative inactivity on the part of Fritz. But whether Fritz is active or not, the harrassing fire by our little guns goes on day and night, the intensity depending on the importance of the front. It is our policy to fire on every German who can be reached, and our 18-pounders can reach considerably farther than is generally known.

No doubt the enemy intends to make a big drive again very

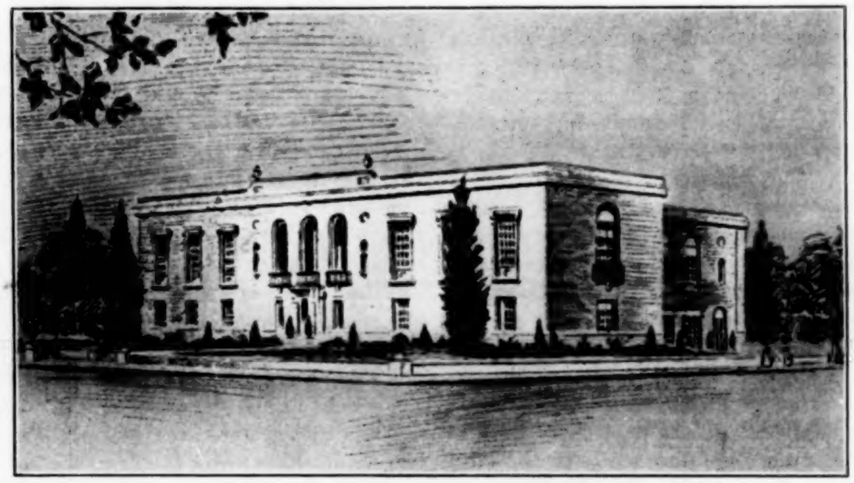
soon. It is like living on a volcano, but we all feel extremely confident that the showing to be made by the Allies will far surpass those in the past. Every one is working hard and as far as I can judge the stage is set for the greatest battle in history. We are all grateful to Uncle Sam for the real response he is making to our call for assistance. The American soldiers I have seen here are just the type we Britishers are proud to have as fighting partners, and with such men as you are sending over, together with the wonderful French and Italian soldiers, there can be only one result, a clean win for our side.

Bdr. P. G. Welford.

The Dayton Engineers' Club and Its New Building

An ideal home, yes, and more than that, a home of ideals.

This characterizes the Engineers' Club of Dayton in its new home, which it was the pleasure of the Secretary to visit a short time ago during a trip through the West and South. Our Society, in company with others, had been cordially invited to the original organization meeting of the Dayton Engineers' Club several years ago; and similarly to the dedication of its beautiful new clubhouse last February, which, however, the Secretary was unfortunately unable to attend. Suffice to say that whereas there may be engineers' club buildings which have cost more, as in the case of the Engineers' Club in New York, nevertheless, there is no more beautiful and well-appointed engineers' clubhouse in the world than the one which can now be found in the city of Dayton.



New Home of the Engineers' Club of Dayton

The original conception recognized that a meeting place permitting the fearless and thorough discussion of engineering problems, coupled with the fostering of good fellowship, was quite worth while and would confer lasting benefits upon the community. The splendid building came as a result of the generous desire of two of Dayton's public-spirited engineers, both of whom, incidentally, are members of our Society. The building is located on a choice lot facing the river, with adequate grounds to give it a setting, and is substantially constructed with a view to permanence and utility. The entrance to the main floor is generous and attractive. On the right is a common room, with piano, comfortable divans and pool tables. In the center are the main stairs up. To the left are the lavatories and rooms for checking wraps. Two or three steps down and in the center are the main rest rooms, with possibilities for dining *al fresco*. Upstairs is the main auditorium, with a large lounge on the right and library on the left.

Notwithstanding the excellence of the architecture and setting of the building, which, obviously, are so favorable, the impressive feature of all is that the Dayton Engineers' Club is dedicated to:

The dissemination of the Truth,
The promotion of useful education and civic righteousness,
The fostering of good-fellowship among our Miami Valley Engineers,
The professional advancement of our members,
The inspiration and encouragement of the younger men,
The making of a technical City, where creative endeavor finds reward.

Nothing could so hearten the work of the engineer, and particularly of the young engineer, as to see this evidence of idealism and devotion to the higher things of life in relation to his daily work.

History of the Providence Engineering Society

In the Providence Magazine for May 1918, published by the Providence Chamber of Commerce, there appears a history of the Providence Engineering Society, written by Luther D. Burlingame, Mem.Am.Soc.M.E., from which the account given below is taken. This society bears the distinction of having been originated, and until within a few years conducted, in the interests of those in the mechanical engineering profession. For several years past it has been affiliated with the American Society of Mechanical Engineers.

As far back as 1789 the Providence Association of Mechanics and Manufacturers was organized for the purpose of "promoting industry and giving a just encouragement to ingenuity, that our manufactures may be improved." This association had on its rolls the names of many distinguished men. The meetings were held in the Old State House, where an important library was collected, which became in 1877-1878 the nucleus of the present Providence Public Library.

Following the dissolution of this old organization, a group of men interested in mechanics and mechanical engineering, came together in 1894 to form an organization devoted to the interests of those mechanics branches. A constitution was adopted and the society started on its work with twenty-seven charter members. Arthur A. Fuller, now with Stone & Webster Co., Washington, was the first president. The name Rhode Island Association of Mechanicians was first adopted but as it did not seem to fit the ambitions of the leaders of the new organization, the name was soon changed to the Providence Association of Mechanical Engineers, under which title its activities were carried on for more than twenty years.

The first regular technical meeting was held on March 12, 1895, and was a lecture on electricity by Marion C. Happoldt, one of the charter members. During the first year practically all of the lectures and papers were by members and local engineers. In the early years a group of men from the Brown & Sharpe Manufacturing Co. were especially active in the organization and Luther D. Burlingame was the second president.

In 1911 the Association broadened its field of activities by becoming affiliated with The American Society of Mechanical Engineers, and joint annual dinners with the officials of that

Society, the first of which was held May 3, 1911, became important and regular events. In November 1915, at a joint meeting and dinner, with several hundred members of the Boston Engineering Society as guests, plans were consummated for the merging of the old Providence Association of Mechanical Engineers into the present Providence Engineering Society. The purpose of the reorganization was to bring together all classes of engineers in a single organization, modern requirements being such that all the various branches of engineering are found to have much in common, even though there may be wide variation in the technical requirements of each branch. The spirit of coöperation was shown at a recent meeting when there were present as speakers the presidents of the mechanical, civil and electrical national engineering societies.

In order that the specific interests of each group of engineers may be properly cared for in the larger organization, sections have been organized, representing each of the engineering interests most prominent in Rhode Island. These comprise sections on efficiency, municipal engineering, structural work, designing and drafting, power, machine shop, and chemistry. In addition there is a student section, making it possible for student engineers to be identified with engineering activities, with which they may later find themselves connected in a professional way.

An important program has been arranged for next season. During the past year there have been held eleven regular meetings of the society and fifty section meetings. Addresses on matters of current interest have been presented by engineers of national prominence at the regular meetings while the section meetings have been devoted especially to matters of engineering connected with the war.

The society has in operation an employment bureau for the reciprocal benefit of its members. It also publishes a monthly bulletin containing the program for future meetings and other items of interest to the members. Quite recently the society carried out a complete classification of the engineers throughout the state showing their availability for military or auxiliary civilian service. In addition to this work the society made several suggestions, which were later adopted, with reference to the proper guarding of public utilities and the securing of emergency fire-fighting apparatus. During the past year there has been an increasing number of the society members in the Service, and the service flag now contains thirty-five stars.

The present president of the society is Robert W. Adams and it is due largely to his energy and interest that the society is steadily progressing, the membership now being approximately 500. The society has attractive headquarters in the Dr. Carr building, 29 Waterman Street.

Edgar Marburg

Edgar Marburg, professor of civil engineering in the University of Pennsylvania and secretary-treasurer of the American Society for Testing Materials, died suddenly in Philadelphia on June 27.

Professor Marburg was graduated from Rensselaer Polytechnic Institute in 1885 with the degree of civil engineer and served successively in the engineering departments of the Keystone Bridge Co., the Phoenix Bridge Co., the Edge Moor Iron Co. and the Carnegie Steel Co. In 1892 he was named for and accepted the position of the head of the civil-engineering department in the University of Pennsylvania.

In 1898 Professor Marburg was one of the group to organize in Philadelphia the American Section of the International Association for Testing Materials and early in 1902 he was elected secretary of the section. Within a few months he had written to the executive committee such a clear statement of the purposes which an American testing society should fulfill that the committee decided to recommend the termination of the existence of the section as such and the establishment of a new society, which would hold membership as a body in the international association and, while affiliated and forming the American branch, be free to set forth its aims independently and adopt its own mode of precedure. The plan for the new society was drawn up on the lines laid down by him—which are those followed today—and the new body formally launched as the American Society for Testing Materials in June 1902 with Dr. Charles B. Dudley as president and himself as secretary-treasurer.

What the success of the society has been is not necessary to recount in detail. It is sufficient to say that the membership is now 2261, the annual receipts $39,687, while the standards it has adopted number 107. So excellent has been the work accomplished that the Government has in the last two years translated certain of the specifications into foreign languages, thus making the society work a helpmeet in the extension of American foreign trade.

While the profession knows him chiefly for his work in the society, Professor Marburg was no less successful as a teacher. In conjunction with his colleague in mechanical engineering, the late Prof. Henry W. Spangler, he deserves credit for having planned the excellent engineering laboratories of the university. The most important of his writings was his book on Framed Structures and Girders, published in 1911. For years he was a contributor of editorials to the *Engineering Record*.

Professor Marburg was a member of the American Society of Civil Engineers, past-president of the Engineers' Club of Philadelphia, past-secretary of the Society for the Promotion of Engineering Education and past-chairman of the committee on science and arts of The Franklin Institute. He was honored with the degree of doctor of science by the University and of doctor of laws by Franklin and Marshall College.

Dr. James Douglas

Dr. James Douglas, honorary member of the American Institute of Mining Engineers, died June 25, 1918, at the age of 81, in his home in New York. He was a scholarly man of the highest professional attainments. Besides being rated one of the foremost metal and mining authorities in the world, he had a deep interest and sympathies in the field of philanthropy.

To the engineering profession he contributed not only from his knowledge but also from his possessions. In 1915 he made an initial gift of $5000 to the Engineering Societies Library for an endowment fund, to which he added $95,000 in 1916, making his total donation $100,000. By the provisions of his will a bequest of another $100,000 has been made to the American Institute of Mining Engineers for library purposes.

A brief review of his life shows an unusually versatile and brilliant mind, which led him to make important contributions to an extraordinary variety of professions.

Dr. Douglas was born in Quebec, Canada, in 1837 and educated at the University of Edinburgh where he began his study of medicine, and at Queen's University, Kingston, Ontario. He traveled extensively in Europe and the Orient, visited Egypt several times, and brought back from his travels important archæological collections which he later donated to the Metropolitan Museum of Art.

After the period of travel he returned to Edinburgh and continued his studies in medicine and surgery, and subsequently entered the ministry with the idea of combining the

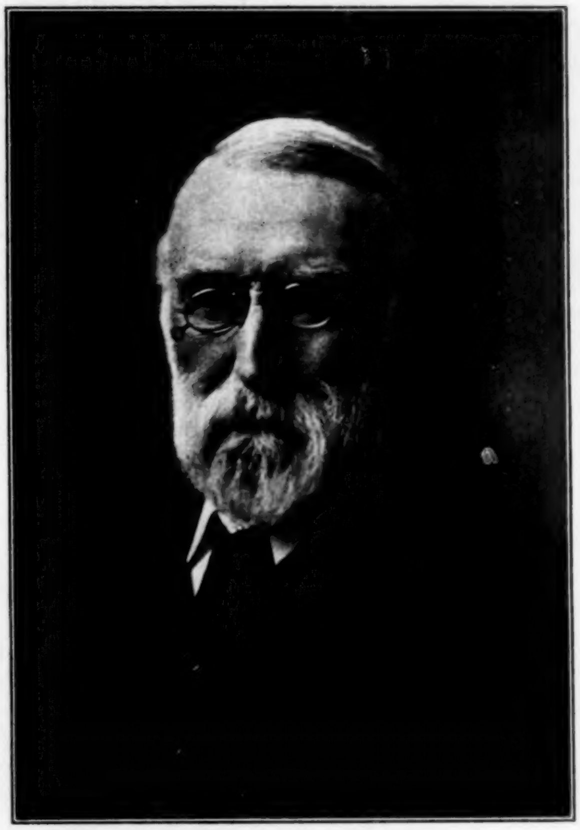
two professions. In the full swing of his studies in medicine, theology and literature, however, his plans were suddenly changed. His father had invested heavily in gold and copper mines in Canada and seemed in danger of losing his entire fortune because there was no economical process of extracting the two per cent copper ore the mines contained. Dr. Douglas had been much interested in chemistry and the jeopardy of his father's finances led him to take up the subject practically in connection with mining. He returned to Canada again where, in collaboration with his friend, the late Dr. Hunt, he worked out the well-known Hunt & Douglas process for the extraction of copper.

Dr. Douglas came to this country in 1875 and became connected with several copper companies in applying his theory of extraction, finally entering into business relations with the firm of Phelps, Dodge & Co., of which he later became president and chairman of the board of directors. It has been said that Dr. Douglas supplied the imagination which, added to the money and careful business management of the members of the firm, raised this company to its very high place among mining industries.

It was on his suggestion that the first traction engines used in the Southwest were employed in hauling coal from Bisbee to the railroads. He built the railroad from Bisbee to Fairbanks to further facilitate the handling of the ore, and otherwise developed facilities for conducting mining operations on a large scale for the delivery of the coal.

Dr. Douglas' liberality and broadmindedness made him the friend of the engineering profession. His mines and smelting plants were always open to other engineers, with whom he believed an exchange of ideas mutually beneficial. In this connection H. W. Hardinge tells that a chance remark of Dr. Douglas' resulted in changing the whole method of copper smelting in Colorado. The remark led Mr. Hardinge to convert his lead stack into a composite lead and copper furnace, a change which increased the profits in smelting so largely and rapidly that other smelters hastened to adopt similar methods.

Both Queen's University and McGill University conferred the degree of LL. D. on Dr. Douglas, and he was the recipient of the gold medal of the Institution of Mining and Metallurgy, as well as the John Fritz Medal, which was awarded to him for notable achievements in mining, metallurgy, education and industrial welfare.



Dr. James Douglas

His writings include a long list of articles on mining, metallurgy and railroads, besides several important historical volumes.

ANNUAL REPORT OF THE SECTIONS ACTIVITIES

The year just closed has been marked by progress in the development of the Sections, both in strengthening the local organizations and in mutual service between the parent body and the Sections.

Several innovations have contributed to this progress. The new By-Laws, approved by the Council Meeting in October and published in the November issue of The Journal, govern the activities of each Section to the extent of insuring that its procedure is in conformity with the Constitution of the Society. They leave each Section free to carry out the details of its coöperative work with other societies' sections and its activities of local interest.

At the Annual Meeting in December 1917 the importance of the Sections received official recognition in the first Sections' Session. Delegates from each Section gave a three-minute talk, followed by a general discussion. Many interesting suggestions for development were given at the Sections Session of the Annual Meeting. The possibilities for increasing the membership of the Society through the Sections seemed very practicable. The mechanical engineer, whose work is most often in the industries, is in the forefront of industrial life at this time, and the number of men in this profession is increasing rapidly. At the Spring meeting the Sections Conference contributed still further toward carrying out the ideas evolved in December, and in giving national impetus to the Society's plans for speeding up war industries. An amendment to the Constitution of the Society whereby the voting membership would elect the Nominating Committee, using the organizations of the Sections to effect the election, is a further step in democracy in the Society and was presented at the Spring meeting.

The plan of the Sections Committee of holding its meetings in cities where there are Sections of the Society and where they can get in direct touch with some of the Sections has also been a strong factor in keeping the Sections closely in touch with the Society. Meetings of this kind have been held in Bridgeport, St. Louis, Milwaukee, Chicago, Detroit and Philadelphia during this year.

The first state Section has been organized this year in Connecticut and includes branches in Bridgeport, Hartford, Meriden, New Haven and Waterbury.

Work Undertaken this Year

While the work undertaken in the different Sections has been quite varied, the dominant idea has been that the only worth-while activities were those relating to the war. The

part taken by the engineering profession in local activities of all kinds this year is noteworthy and in line with the enlarged field for engineering as it has been recently outlined. In Atlanta the influence of the local Section brought about the establishment of an advisory board of consulting engineers for the city, thus raising the engineering department beyond the reach of politics. This Section was also instrumental in getting a department of mechanical engineering for the city of Atlanta, which is believed to be the only city in the United States with such a department. In Philadelphia, one of the Sections papers dealt with a mathematical analysis of the Federal Income Tax Law, in which the defects of this law were clearly set forth; this is an interesting example of the engineer's application of his principles to the broader problems of life. The Baltimore Section has been recognized by the Fuel Administration and one of its committees asked to work on material for that adminstration. Baltimore has also given considerable discussion to the subject of economies in the canning business, which is one of Maryland's most important industries; this subject has been discussed from the standpoint of savings in the actual handling of the material to be preserved as well as in the fuel and equipment of the plants. In Detroit the problem of technical education for women has been given considerable attention and a movement set on foot to interest other localities and colleges in this work. The New York Section has discussed the question of labor turnover, thus recognizing the fact that the engineer is the connecting link between labor and capital in a large part of the industries of the country. The non-essential industries have also formed the subject of one meeting of the New York Section, in the discussion of which a resolution was passed to the effect that the Society organize to develop the use of any of the available equipment and working forces of plants not engaged directly in manufacturing war necessities.

Sections and The Journal

The Sections Committee has been desirous that the Sections should contribute a share of papers for publication in THE JOURNAL, and to that end requested that each Section submit two papers to the Publication Committee each year. Sixteen papers given at Section Meetings have been published this year. A splendid suggestion in this regard was made at the Sections Session of the Annual Meeting, which was to assign a subject to two or three Sections where that topic is of special local interest; for example, the Boston, Chicago, San Francisco and New Orleans Sections might work up a symposium on shipbuilding. It was felt that the Sections might contribute important aid to the country in this way.

In this connection, the Committee also recommended that something be done in the line of research work, the importance of which at this time is urged upon us by the action of our Allies in this direction. Many of the Sections have appointed committees to give special attention to research work in connection with local colleges and industries.

Sections and Visits of Officers

In the fall of 1917 President Hollis visited the Sections at St. Louis, Los Angeles and San Francisco, and spoke on behalf of the Society at El Paso, Seattle and Portland. At the same time the Sections Committee was meeting with the Sections of the Middle West.

Secretary Rice's visits to a large number of the Sections are believed to have been extremely valuable in correlating the war activities which the Society can carry on only through the medium of its Sections. All the Sections presented a patriotic atmosphere, and everywhere the enormous part played by the engineers in war activities was most striking. Mr. Rice or Mr. Hartford attended meetings at Indianapolis, Cincinnati, New Orleans, Chicago, Toronto, Detroit, Bridgeport, Meriden, New Haven, Boston, and a joint meeting at Birmingham of the Atlanta and Birmingham Sections, besides attending meetings of engineers at Toledo, Dayton and Duluth. In all localities it was the consensus of opinion that meetings of engineering organizations are well worth while at this time.

The Council visited the Chicago Section on November 16, and the Philadelphia Section on April 23, holding its regular monthly meetings at those respective places and times. On each occasion the Council attended the meeting of the Section, in the evening.

Coöperation with Student Branches

The value of coöperation was well illustrated when the New York Section turned its April meeting over to the Metropolitan Student Branches at Columbia University, New York University, Polytechnic Institute of Brooklyn and Stevens Institute of Technology. This event brought out an attendance of 300 persons in the afternoon, more than 400 at dinner, and between 600 and 700 in the evening.

Our Present Sections

This year the Society has added the new formation of the Connecticut State Section. The affiliation of the Providence Engineering Society, whose proceedings are reported in THE JOURNAL, still continues a source of mutual benefit. The rest of the Sections are located in Atlanta, Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Detroit, Erie, Indianapolis, Los Angeles, Milwaukee, Minnesota, New Orleans, New York, Ontario, Philadelphia, St. Louis, San Francisco and Worcester. A map published in the November issue of THE JOURNAL shows the geographical locations of the Sections to be fairly well distributed over the country. The total number of Sections is now twenty-one, one of which has five branches, and the establishment of several new Sections is contemplated at present.

Meetings and Attendance

More than 150 meetings have been held in the various Sections this year, all of which have been reported in THE JOURNAL. The Buffalo Section holds weekly meetings, and Indianapolis reports one all-day session with morning, afternoon and evening sessions. The reports show the various meetings to have been very well attended. At Meriden over 175 engineers were present at the June meeting; 200 attended in Bridgeport, and in Boston more than 400 gathered at one meeting in June.

New Record Book

A new record book has been sent to all local sections in order to assist the secretaries of the various Sections in keeping their records. This is of value in systematizing and simplifying the routine work of the Sections and should allow more time to be spent in the more important work of the Sections—that of preparing, selecting and reporting the papers of the meetings. Another good feature of the book is the information concerning other Sections, which is especially valuable at this time when we are engaged in war work. The Committee on Sections would be glad to receive suggestions from members regarding any additions or alterations to this book.

Detailed annual reports from each Section will be published in the September and subsequent issues of THE JOURNAL.

PERSONALS

IN these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by August 15 in order to appear in the September issue.

CHANGES OF POSITION

William F. Parish, formerly aeronautical mechanical engineer, Signal Corps, Equipment Division, Specification Section, has assumed the duties of chief of Oil and Lubrication Branch of the Supply Section of the Department of Military Aeronautics.

F. Raymond Jackson has severed his connections with the firm of J. E. Sirrine, mill engineer and architect of Greenville, S. C., and has accepted a position in the mechanical section, department of concrete ship construction, of the Emergency Fleet Corporation, U. S. Shipping Board, Philadelphia, Pa.

David S. Wegg, until recently manager of the Telluride Realty Company, Salt Lake City, Utah, is serving as supervising inspector of ordnance material in the Chicago district, with headquarters at the plant of the Standard Steel Car Company in Hammond, Ind.

C. B. Banch has accepted a position with the U. S. Steel Corporation, ordnance department, Ambridge, Pa., as designing engineer. He was formerly in the employ of Corrigan, McKinney and Company, of Cleveland, Ohio, in a similar capacity.

Charles F. Merrill has resigned his position as chief engineer of the James Hunter Machine Company, North Adams, Mass., to take a position in the Southern sales department of the Draper Corporation at Atlanta, Ga. Mr. Merrill was for several years connected with the engineering department of the Draper organization at Hopedale, Mass.

Lewis S. Maxfield has resigned from the motive-power department of the Interborough Rapid Transit Company and New York Railways Companies, New York, to become associated with the Nate-Earle Company, engineering contractors of the same city, as assistant engineer.

W. Herman Greul, for some years identified with the Otis Elevator Company, New York, has been made president of the Standard Plunger Elevator Company, Worcester, Mass.

Arthur Seubert, formerly instructor in mechanical engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y., has entered the service of the New York Edison Company, New York, in the capacity of assistant to mechanical engineer.

Charles W. Vocke, formerly mechanical engineer with the Nitrogen Fixation Corporation, New York, has become affiliated with the National Aniline and Chemical Company, Wappingers Falls, N. Y.

Augustus H. Lane has left the employ of the Grant Hammond Manufacturing Corporation, of New Haven, Conn., and has taken a position in the engineering department of the Government at Watervliet Arsenal.

Francis L. Barstow has become affiliated with the Falulah Paper Company, Fitchburg, Mass. He was formerly connected with the Worden-Allen Company, Chicago, Ill.

William R. Crute has resigned his position of chief engineer of the Champion Fiber Company, Canton, N. C., to accept the position of aero mechanical engineer, naval aircraft factory, Navy Yard, Philadelphia, Pa.

Harry B. Chapman, formerly manager of the Chapman Engineering Company, Texas City, Tex., has entered the service of the Westinghouse Electric and Manufacturing Company Machine Works, East Pittsburgh, Pa.

John W. Kittredge, until recently designer with the Firestone Tire and Rubber Company, Akron, Ohio, has accepted a similar position with the Diamond Match Company, of Barberton, Ohio.

Joseph E. Sheedy, assistant manager, Seattle Construction and Dry Dock Company, Seattle, Wash., has become associated with the Erickson Engineering Company of the same city.

Joseph H. Cheetham, formerly chief mechanical engineer, McNab and Harlin Manufacturing Company, Paterson, N. J., has assumed the duties of superintendent of the Kunkle Valve Company, Fort Wayne, Ind.

C. Edwin Clarke has assumed the duties of master mechanic, Saucon plant of the Bethlehem Steel Company, Bethlehem, Pa. He was formerly affiliated with the Wilmington Steel Company, Wilmington, Del., in the capacity of chief engineer.

Joseph J. Nelis, formerly with the Babcock and Wilcox Company, Cincinnati, Ohio, has accepted a position with the U. S. Shipping Board, Emergency Fleet Corporation, Technical Division, Philadelphia, Pa. Mr. Nelis will be engaged in boiler work.

ANNOUNCEMENTS

Joseph N. Mahoney has severed his relations with the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., to take up the practice of consulting mechanical and electrical engineer, with offices in New York. He will specialize in the design and application of railway brake and control apparatus of the mechanically, electrically or pneumatically operated forms; also industrial and power electrical control and switching equipment.

Frederic F. Gaines, superintendent of motive power, Central of Georgia Railway, Savannah, Ga., has become a member of the Board of Railroad Wages and Working Conditions, with headquarters at Washington, D. C.

B. M. Baxter, for nine years associated with H. B. Prather, consulting engineer of Cleveland, has severed his connection with Mr. Prather and has opened an office in the same city to conduct a consulting engineering business in steam-power-plant and mill-building work, specializing in paper-mill engineering.

Oliver C. Irwin, until recently associated with the Frick Company of New York, as refrigerating engineer, has opened an office at 291 Broadway, New York, under the firm name of O. C. Irwin and Company, Engineers.

R. Sanford Riley, president of the Sanford Riley Stoker Company, Ltd., Worcester, Mass., and of the Murphy Iron Works, Detroit, Mich., has been requested by the Emergency Fleet Corporation to arrange for supervision of trial trips of all merchant ships now being turned out in this country. He has undertaken the organization of this department for the Emergency Fleet Corporation, but has an arrangement by which he will retain supervision of his other interests during his connection with the Corporation. Before going into the stoker business, Mr. Riley had an extensive experience in marine engineering and shipbuilding. His qualifications were called to the attention of Mr. Charles M. Schwab by former shipbuilding associates, which resulted in his call to service.

F. L. Churchill has enlisted in the service of the U. S. Shipping Board for the duration of the war, and is now stationed on the S. S. *Suriname*. He was formerly affiliated with the Fafnir Bearing Company, of New Britain, Conn.

A. C. Thomas has assumed the duties of equipment superintendent, liquid air department of the Air Nitrates Corporation, Mussel Shoals, Ala.

John R. Shea left on July 15 for Tokyo, Japan, to represent the Western Electric Company's manufacturing interests there. He was formerly connected with the Chicago plant of the company, as head of the production methods division.

William F. Schweigert has been elected secretary of the Niagara Machine and Tool Works. He will continue to give special attention to the sales department by attending to the most important work on the road. Mr. Schweigert has been affiliated with the company for 30 years.

Miller Reese Hutchison, associated for several years as chief engineer of the laboratory in West Orange with Thomas A. Edison, President of the Naval Consulting Board, has resigned from the Edison interests to devote his entire time to the prosecution of the war. Dr. Hutchison is a member of the Naval Consulting Board.

Harry Cowen, until recently assistant engineer of car equipment, Interborough Rapid Transit Company, New York, has been transferred to the position of general foreman of the mechanical department of the New York Railways Company, New York.

Warren C. Drake, for the past 12 years connected with the stoker-engineering department of the Westinghouse Electric and Manufacturing Company, New York, has resigned this position. He has entered into partnership with H. S. Sleicher, and has opened an office in New York, under the firm name of Sleicher and Drake, for the handling of power-plant equipment.

Joseph Breslove, until recently sales engineer with the Allis-Chalmers Manufacturing Company, Pittsburgh, Pa., has opened an office in the same city, and will carry on a general consulting practice, specializing in power-plant work.

Frank C. Turner, formerly representative of the Southern Wheel Company, Birmingham, Ala., has assumed the duties of vice-president of the same company, with headquarters at St. Louis, Mo.

Max K. Grossheim is now in charge of the engineering department of L. O. Koven and Brothers, boiler makers and engineers, of Jersey City, N. J. His former duties with this concern were those of designer.

APPOINTMENTS

Col. Charles C. Jamieson, Lieut-Col. H. B. Hunt and Lieut-Col. W. P. Barba are among the members of a board appointed by General C. C. Williams, Acting Chief of Ordnance, to represent the Ordnance Department in the preparation and approval of plans for the construction of the Neville Island plant for heavy cannon and projectiles to be constructed by the United States Steel Corporation. The board will coöperate with the corporation in the planning, construction and operation of the plant.

H. H. Esselstyn, associated with the U. S. Shipping Board, Emergency Fleet Corporation, has been appointed Commissioner of Public Works, Detroit, Mich., and will assume his office when he obtains his release from the U. S. Shipping Board. Mr. Esselstyn is senior member of the firm of Esselstyn, Murphy and Hanford, of the same city.

John W. F. Bennett, member of the firm of Goodrich, Hoover and Bennett, consulting engineers of New York, has been appointed Major in the Construction Division of the Quartermaster's Corps. National Army.

Ross Anderson has been appointed manager at the Accessory Plant of the American Locomotive Company, Richmond, Va. Mr. Anderson was superintendent at their Pittsburgh plant for the last year, and prior to that manager of the Poole Engineering and Machine Company, Baltimore, Md.

Albert G. Suttill has been appointed inspector for the Merchant Shipbuilding Corporation, of Bristol, Pa., in charge of the Boston district.

George R. Henderson has been appointed Administrative Engineer for Pennsylvania, under the Federal Fuel Administration.

ROLL OF HONOR

Abernethy, A. A., U. S. Naval Reserve Force, in training at U. S. Steam Engineering School, Hoboken, N. J.

Allison, John R. A., Second Lieutenant, Engineer Officers' Reserve Corps, General Engineer Depot, U. S. Army, Field Inspection Service.

Arnold, John A., Camp Meade, Md.

Barba, W. P., Lieutenant-Colonel, Ordnance Department, N. A., Ordnance Department Board of Construction of U. S. Steel Corporation Plant.

Barton, Warren H., Co. H, 2d Engineers' Regiment, Camp Humphrey, Va.

Bates, D. M., Major, U. S. Army.

Bennett, John W., Major, Construction Division, Quartermaster's Corps, N. A.

Berliner, R. W., Major, Quartermaster's Corps, U. S. Army.

Budwell, Leigh, Second Lieutenant, Engineer Officers' Reserve Corps, 61st Engineers, Fort Benjamin Harrison, Ind.

Childs, Harold P., First Lieutenant, Truck Co. No. 2, First Battalion, 23d Regiment Engineers, American Expeditionary Forces, France.

Coleman, R. J., First Lieutenant, Ordnance Officers' Reserve Corps, Ordnance Department, American Expeditionary Forces, France.

Cox, Abraham B., Captain, Ordnance Officers' Reserve Corps, Ordnance Department, American Expeditionary Forces, France.

Derby, Gardner C., Ensign, U. S. Naval Reserve Force, U. S. Naval Academy, Annapolis, Md.

Dilts, Frank B., Captain, Ordnance Officers' Reserve Corps, Ordnance Department, U. S. Army, stationed at Watervliet Arsenal, N. Y.

Drake, Charles L., First Lieutenant, Ordnance Officers' Reserve Corps, Sandy Hook Proving Ground, Fort Hancock, N. J.

Edimann, Frank L., Ensign, U. S. Naval Reserve Force, Aviation.

Frankel, Monroe J., 4th Battery, Field Artillery, Officers' Training Camp, Camp Zachary Taylor, Ky.

Fuhr, Harry E., Ensign, U. S. Navy.

Gates, S. J., Captain, Engineer Officers' Reserve Corps, American Expeditionary Forces, France.

Haney, James B., Captain, Ordnance Officers' Reserve Corps, Ordnance Department, U. S. Army, American Expeditionary Forces, France.

Hunter, H. C., Co. C, 304th Battalion, N. A., Camp Colt, Gettysburg, Pa.

Irwin, K. M., U. S. Naval Reserve Force.

Kemble, Parker H., Lieutenant, U. S. Naval Reserve.

McLindie, First Lieutenant, Ordnance Officers' Reserve Corps, Rock Island Arsenal, Rock Island, Ill.

Marshall, Waldo H., Colonel, Ordnance Officers' Reserve Corps, Production Division, Ordnance Department, U. S. Army.

Mayer, James Leo, Lieutenant, 109th Engineers, Camp Cody, N. M.

Myers, Curtis C., Captain, Ordnance Officers' Reserve Corps, U. S. Army.

Peter, Albert G., First Lieutenant, Ordnance Officers' Reserve Corps, stationed at the Philadelphia District Ordnance Office.

Rosenthal, Emanuel, Sergeant, Co. D, 19th Platoon, 56th U. S. Engineers, American Expeditionary Forces, France.

Ruppel, Richard L., Captain, Quartermaster's Corps, N. A., Construction Division.

Sanders, Walter C., Lieutenant, Battery F, 64th Heavy Artillery (C. A. C.), American Expeditionary Forces, France.

Shearer, David R., First Lieutenant, Aviation Section, Signal Officers' Reserve Corps, Finance Department, Approvals Section, U. S. Army.

Sladky, A. C., Captain, Ordnance Officers' Reserve Corps, Production Division, Ordnance Department, U. S. Army.

Swift, Henry, First Lieutenant, Ordnance Officers' Reserve Corps, Inspection Division, Ordance Department, U. S. Army.

Taylor, Charles Fayette, Lieutenant (Junior Grade), U. S. Naval Reserve Flying Corps, stationed at Washington Navy Yard.

Tayman, George S., Chemical Section, Division of Mechanical Research, N. A., American University, Washington, D. C.

Teague, Newton N., Second Lieutenant, Aero Engineer Officer, Air Service, N. A., U. S. Army.

Treuhaft, A. A., Ordnance Engineering School, Aberdeen Proving Grounds, Md.

Wagenseil, E. W., Lieutenant (Junior Grade), U. S. Naval Reserve Force, Naval Reserve Flying Corps Repair Base, France.

Warner, First Lieutenant, Engineer Officers' Reserve Corps, American Expeditionary Forces, France.

Woobank, Wilfred, Private, Meteorological Section, Signal Corps, U. S. Army, Texas A. & M. College, College Station, Tex.

Wood, C. E., Chemical Warfare Section, N. A.

Worthen, Charles B., Second Lieutenant, Military Aeronautics Division, U. S. Army.

Yardley, R. W. E., Captain, Ordnance Officers' Reserve Corps, Ordnance Department, U. S. Army.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER SEPTEMBER 10

BELOW is the list of candidates who have filed applications since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. Total number of new applications, 253.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by Sept. 10, and provided satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about Oct. 15.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Alabama

RICHARDSON, WILLIAM, JR., Construction Engineer, Tennessee Coal, Iron & Railroad Co., Ensley
WATSON, CHARLES E., Chief Engineer, Alabama Dry Dock & Shipbuilding Co., Mobile

California

JOHNSSON, MONS J., Outside Superintendent, Pacific Portland Cement Co., Cement.
MEESE, CONSTANT, President and Directing Manager, Meese & Gottfried Co., San Francisco
SCHWEITZER, R. R., Vice-President and General Manager, Western Machinery Co., Los Angeles

Colorado

BIER, PETER, Mechanical Engineer, Construction Department, Great Western Sugar Co., Denver
GILBERT, GEORGE T., Consulting Engineer, Denver
LESTER, WILLIAM, General Superintendent and Chief Engineer, Vulcan Iron Works, Denver

Connecticut

ARCHER, SYLVANUS, Assistant Superintendent, Bank Lock Dept., Yale & Towne Mfg. Co., Stamford
BARNES, FRED L., Estimator and Salesman, Eastern Machinery Co., New Haven
CLEVELAND, FRANK W., Assistant to Superintendent of Equipment, Pratt & Whitney Co., Hartford
COLVIN, BENJAMIN J., Power Engineer, Sidney Blumenthal & Co., Inc., Shelton
CROCKER, JOHN F., Comptroller, Bridgeport Brass Co., Bridgeport
LINTON, SAMUEL A., Foreman, Pratt & Whitney Co., Hartford
MARSHALL, CARL, Welfare Manager, Pratt & Whitney Co., Hartford
VALENTINE, AUGUST L., Superintendent, Pratt & Whitney Co., Hartford

Delaware

BARSTOW, JOHN S., Engr., E. du Pont de Nemours & Co., Wilmington
BERGLAND, WILLIAM S., Engineer, E. I. du Pont de Nemours & Co., Wilmington
LAIRD, WALTER J., Construction Engineer, du Pont Co., Wilmington
NORBOM, TORLEIF S., Superintendent of Marine Machinery, The Pusey & Jones Co., Wilmington

District of Columbia

BROOKS, HENRY W., Mechanical Engineer, U. S. Ord. Dept., Inspc. Div., Washington
CHAPLIN, MERLE P., 1st Lieutenant, Engineer R. C., Engineer Branch, Motor Transport Service, Unit F, 7th Wing, Washington
DAHLQUIST, CHARLES S., Major, Q. M. C. N. A., Motor Transport, Supervisor of Inspection, Inspection Division, Washington
HARRIS, GLENN B., Gauge Engineer, Inspection Div., Ord. Dept., Washington
McCONNELL, JAMES W., Master Mechanic, Torpedo Tube Shop, Washington Navy Yard, U. S. Naval Gun Factory, Washington

Florida

RAGONNET, EUGENE L., Mechanical Engineer, Cuba Cane Sugar Corp., Miami

Georgia

TUFTS, R. BARRY, Engineer and Contractor, Private Practice, Atlanta

Illinois

BENNETT, WILMER C., Structural Engineer, Private Practice, Chicago
COLE, AUSTIN, President and General Manager, Western Valve Bag Co., Chicago
FRYE, RAYMOND P., Chief Draftsman, Amalgamated Machinery Corp., Chicago
GOOLEY, JOSEPH E., Sales Engineer, The Imperial Brass Mfg. Co., Chicago
PEACOCK, CHARLES M., Mechanical Engineer, Equipment, D. A. Wright, Chicago
WACHS, CHARLES L., Vice-President, The E. H. Wachs Co., Chicago

Indiana

BAYLOR, CHARLES A., Superintendent, Great Western Mfg. Co., La Porte
BERTSCH, LAWRENCE H., Vice-President and Chief Engineer, Bertsch & Co., Cambridge City
JACOB, WILLIAM, Chief Car Draftsman, C. C. C. & St. L. Ry., Indianapolis
LEWIS, EDWIN H., Assistant to Inspection Manager, Inspection Div., Ordnance Dept., Standard Steel Car Co., Hammond
LUTEN, DANIEL B., Designing and Consulting Engineer, Private Practice, Indianapolis
PILKINGTON, ROBERT G., Automotive Engineer, Dodge Mfg. Co., Mishawaka

Kentucky

MOORE, CLARENCE S., Chief Engineer, Lex. Laundry Co., Lexington

Louisiana

GRANT, ARTHUR A., New Orleans Mgr., Freeport & Mexican Fuel Oil Co., New Orleans

Maryland

MORGAN, MERTON W., Chief Draftsman, Poole Engineering & Machine Co., Baltimore
WILLIAMS, JESSE W., Master Mechanic, By-Product Coke Oven Dept., Bethlehem Steel Co., Sparrows Point

Massachusetts

AMES, BRADFORD L., President, Monarch Soot Remover Co., Boston
BALLENTINE, JOEL E., Mechanical Engineer, A. C. Lawrence Leather Co., Peabody
BENGSTON, CARL, Power Engineer, Norton Co., Worcester
CHASE, ALBERT M., Draftsman, C. W. Praray, Mill Engineer, New Bedford
COPPUS, FRANS H. C., President, Treasurer, Coppus Engineering & Equipment Co., Worcester
DOE, THOMAS B., General Manager, United States Cartridge Co., Lowell
FARNHAM, WALTER E., Head of Engineering Department, New Bedford Textile School, New Bedford
GOLDSMITH, GEORGE H., General Superintendent, James Hunter Machine Co., North Adams
GOUGH, CHARLES M., Construction Department, Watertown Arsenal, Watertown
HOWARD, HENRY F., Engineer, Worcester Mfg. Co., Worcester
HUGHES, JOHN L., Designing and Development Engineer, General Electric Co., Pittsfield
ISLEY, GEORGE H., Mechanical Engineer, Private Practice, Worcester
LAWRENCE, HOWARD B., Engineer, John A. Stevens, Consulting Engineer, Lowell
LOWELL, KARL P., Mechanical Engineer, Fred T. Ley & Co., Inc., Springfield
MAIN, CHARLES R., Special Assistant, Charles T. Main, Engineer, Boston
PENNEY, LOREN W., Mechanical Engineer, Saco-Lowell Shops, Newton Upper Falls
RAMSDELL, THOMAS S., Constructing and Operating Engineer, Monument Mills, Housatonic
SMALL, ERNEST M., Engineering Draftsman, Power House Design, Edison Ill., Co., Boston
SYME, JAMES M., Superintendent, Brown Bag Filling Machine Co., Fitchburg
SZEPESI, EUGENE, Senior Engineer, Cooley & Marvin Co., Boston
WARFIELD, GEORGE L., Superintendent, Thorndike Co., Thorndike

WHEELER, BENJAMIN A., Chief Draftsman, Whitcomb-Blaisdell Machine Tool Co., Worcester
WILSON, HENRY L., Mechanical Engineer, Atlantic Dyestuff Co., Boston.

Michigan

FITZGERALD, JOHN W., Engineer, L. A. Young Industries, Inc., Detroit
GIFFORD, W. ARTHUR, President and Manager, Gifford Engine Co., Lansing
McDONALD, WILLIAM F., Heating Engineer, William F. McDonald Co., Detroit
NESBITT, JAMES W., Assistant Mechanical Superintendent, Packard Motor Car Co., Detroit
POULSEN, EUGENE, Chief Draftsman, The Prescott Co., Menominee
RADFORD, FRED L., Chief Draftsman, Reo Motor Car Co., Lansing

Minnesota

UHL, WILLARD F., Sales Engineer, Private Practice, Minneapolis

Missouri

MALLINCKRODT, EDWARD, JR., Manufacturer, Mallinckrodt Chemical Works, St. Louis

Nevada

CAFFEREY, WILLIS G., Electrical Engineer, Nevada State Hospital for Mental Diseases, Reno

New Jersey

BARRI, JOEL G., Field Mechanical Engineer, c/o T. A. Gillespie Loading Co., South Amboy
CAREW, WILLIAM A., General Superintendent, Morgan Engineering Co., Jersey City
CARLISS, OSWALD T., Chief Inspector of U. S. A. Ordnance, National Vitaphone Corp., Plainfield
CHASE, GEORGE C., President, Chase Adding Machine Corp., Orange
FRENCH, CHARLES M., 1st Lieutenant, Engineers R. C., 34th Engineers, Camp Dix
HOHL, GEORGE I., Mechanical Engineer, Any Package Wrapping Machine Co., Newark
NILIUS, BRUNO, Assistant Chief Mechanical Engineer, American Can Co., Edgewater
VANDERHOOF, ARNOLD H., Ensign, U. S. N. (Retired), Officer in Charge, U. S. Naval Radio Station, New Brunswick
WARNER, MURRAY, in Charge of Utilities, Camp Dix

New York

BARRY, JOSEPH C., Mechanical Draftsman, N. Y. Edison Co., New York
BERMAN, LOUIS K., Vice-President, Raisler Heating Co., New York
BISHOP, CLARENCE A., President and General Manager, The Bishop Calculating Recorder Co., New York
CARL, FRED H., Engineer, Westinghouse Church, Kerr & Co., New York
CASEY, ALBERT O., Engineer on Telephone Apparatus, Western Electric Co., Inc., New York
CUNDALL, ROBERT N., Consulting Engineer, Cundall & Powell, Buffalo
DIBERT, HERBERT M., General Sales Manager, W. & L. E. Gurley, Troy
EMMONS, CHARLES L., Factory Manager, Aeolian Co., New York
GAZIN, LEWIS M., Engineer, Federal Light & Traction Co., New York
GLATHE, BERNHARD, Chief Engineer, The Cuban American Sugar Co., New York
GLENDENNING, WILLIAM J. A., Consulting Engineer, Mech. Rubber Goods & Asbestos Packing, New York
HAMMOND, JOHN W., Secretary, Lake Erie Engineering Works, Buffalo
JENNINGS, WILFRED B., Works Engineer, Worthington Pump & Machinery Corp., Buffalo
LUTHER, GEORGE W., Mechanical Engineer, The Luther Mfg. Co., Olean
MURRAY, HOWARD J., Electrical Engineer, Gibbs & Hill, New York
OLSON, JOHN H., Engineer, M. H. Treadwell Co., New York
PATTERSON, J. CLIFFORD, Testing Department, The Solvay Process Co., Syracuse
PHILIPS, WILLIAM D., Manager of Engineering and Sales, A. S. Nichols Co., New York
ROBLIN, WILMOT H., Inspector of Ord., U. S. O. D., Watervliet Arsenal, Watervliet
SEABROOKE, WILLIAM L., William L. Seabrooke, Chemicals, New York
SHARP, JOHN, Mechanical Engineer, Ferguson Steel & Iron Co., Buffalo
SIMMONDS, PHILIP R., Eastern Sales Manager, Kernchen Co., of Chicago, New York
SLOCUM, HERBERT J., JR., President, Slocum, Avram & Slocum, Inc., New York
SMITH, Engineer, United Gas & Electric Engineering Corp., New York
STEELE, HUGH E., Manager West Coast Machinery Business, W. R. Grace & Co., New York
WETMORE, MINER P., Treasurer and General Manager, The Hygrade Engineering Co., New York
WHITE, ROBERT H., Engineer of Construction, American Locomotive Co., Schenectady

Ohio

BRADLEY, W. H., Vice-President and General Manager, Bedford Coal Co., Coshocton
HUBER, FRANK W., Assistant Superintendent, Forge & Foundry Dept., American Rolling Mill Co., Middletown
MORRIS, JOHN F., Superintendent of Maintenance, Whitaker Glessner Co., Portsmouth
WILSON, ALEXANDER M., Professor Electrical Engineering, University of Cincinnati, Cincinnati
WILSON, HARLAND H., Designing Engineer, McKinney Steel Co., Cleveland

Oregon

BALE, CHARLES W., Chief Engineer, Albina Engine & Machine Wks., Inc., Portland

Pennsylvania

ALBRECHT, ALBERT J., Draftsman, Midvale Steel & Ord. Co., Philadelphia
BENNETT, WILLIAM H., Rolling Mill Supt., Clairton Wks., Carnegie Steel Co., Clairton
BENSON, HARRY L., General Foreman, Machine Shop, The Midvale Steel Co., Philadelphia
CHAPMAN, WASHINGTON H., Engineer, U. S. Ship Building Emergency Corp., Philadelphia
CUPITT, A. WARREN, Equipment Engineer, Midvale Steel Co., Nicetown
GECK, ALBERT A., Superintendent, Colburn Machine Tool Co., Franklin
HARRIS, HENRY S., Sales Engineer, Ingersoll Rand Co., Philadelphia
HARRIS, LESLIE M., Assistant to Vice-President, American Engineering Co., Philadelphia
HATCH, CHARLES W., Assistant Chief Draftsman, American Sheet & Tin Plate Co., Pittsburgh
HENDERSON, RICHARD, Works Engineer, Stanley G. Flagg & Co., Pottstown
HOCKENSMITH, WILBUR D., General Manager and Vice-President, Hockensmith Wheel & Mine Car Co., Penns Station
JAUSS, AUGUST C., Chief Draftsman, Artillery Dept., Midvale Steel & Ordnance Co., Nicetown
LAUBENSTEIN, ALBERT R., Manager and Treasurer, Laubenstein Mfg. Co., Ashland
LYONS, ROBERT J., Assistant Purchasing Officer, Emergency Fleet Corp., Philadelphia
MATTHEWS, JOHN J., Director of Shops, Swarthmore College, Swarthmore
MEYER, CARL F., Sales Manager, Landis Machine Co., Waynesboro
MUNZ, WILLIAM, Mechanical Engineer, Ballinger & Perrot, Philadelphia
OBERSTADT, CARL, Mechanical Expert and Efficiency Engineer, Iron City Products Co., Pittsburgh
OSWALD, HARRY A., Assistant General Superintendent, Naval Aircraft Factory, Navy Yard, Philadelphia
OTTO, WILLIAM F., Sales Engineer, Eynon-Evans Mfg. Co., Philadelphia
ROBERTS, WILLIAM E., Lieutenant, U. S. N. R. F., Asst. Genl. Supt., Naval Aircraft Factory, Navy Yard, Philadelphia
SCOTT, C. LINFORD, General Superintendent, Harrisburg Mfg. & Boiler Co., Harrisburg
TOLSTED, ELMER B., Engineer, Independence Bureau, Philadelphia
VAUCLAIN, JACQUES L., an Assistant to the Vice-President, The Baldwin Locomotive Works, Philadelphia

Rhode Island

OSTBY, RAYMOND E., General Superintendent, Ostby & Barton Co., Providence

South Carolina

KENNEDY, ALFRED D., Vice-President and General Manager, American Machine & Mfg. Co., Greenville

Texas

STEVENS, HARRY L., Consulting Refrigerating Engineer & Supply Co., El Paso

Virginia

HILDEBRAND, CLARENCE K., Designer and Southern Rep., The Ludington Cigarette Mch. Co. of Waterbury, Conn., Salem

Washington

BALLWEG, JOHN H., Electric Engineer, U. S. Spruce Cut Up Mills, Vancouver

Wisconsin

ATHERTON, DONALD H., Instructor Mechanical Engineering, University Extension Div., University of Wisconsin, Madison
RICHARDS, FOREST A., Engineer for Mr. Edward Hutchens, Consulting Engineer, Eau Claire
SPRINK, ISAAC W., Special Inspector and Investigator Engineering Department, Four Wheel Drive Auto Co., Clintonville
ZANTOW, HENRY C., Assistant to Wisconsin State Power Plant Engineer, Mr. John C. White, Madison

Canada

HODGE, CHARLES A., Instructor, Nova Scotia Technical College, Halifax, N. S.
LANG, JAMES, Estimating and Contracting Engineer, John Inglis Co., Ltd., Toronto
VIBERG, ERNEST R., Mechanical Engineer, Canadian Car & Fdy. Co., Ltd., Montreal

England

FOWLER, SIR HENRY, Lieutenant-Colonel, Royal Flying Corps; Superintendent, Royal Aircraft Factory, Derby

Norway

RIDDERVOLD, L. DAHL, Vice-President and Manager, Gustav Nielsen A. S. Toldbedgaten, Christiania

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

California

RIX, HAROLD P., Machinery Merchant, Vice-President, Rix Compressed Air & Drill Co., San Francisco

Delaware

HATCH, JOSEPH R., Fire Protection Engineer, Old Hickory Works, E. I. du Pont de Nemours & Co., Wilmington

Illinois

MILLER, PAUL B., Chief of Section, Apparatus Drafting Dept., Western Elec. Co., Inc., Hawthorne

Iowa

PRAY, JOHN W., Superintendent, City Water Department, Dodge

Massachusetts

CANNITY, ERNEST, Chief Draftsman, Hunter Machine Co., North Adams

WEBSTER, OSCAR A., General Foreman, Machine Shop, Stafford Co., Readville

WHITCOMB, FORREST R., Superintendent, American Radio & Research Corp., Medford, Hillside

New Jersey

GORDON, ROBERT J., Power Engineer, Hercules Powder Co., Kenvil

WHITMORE, RALPH D., Supervising Engineer, American Standard Metal Products Corp., Paulsboro

WOEHL, FRANK, Draftsman and Designer, Babcock & Wilcox Co., Bayonne

New York

DOWNS, CHARLES L., Captain, Army Inspector of Ordnance, U. S. A., Artillery and Artillery Ammunition, New York Air Brake Co., Watertown

Ohio

CLASGENS, JOSEPH H., Assistant Superintendent, The J. & H. Clasgens Co., New Richmond

GIBSON, WILLIAM A., Mechanical Engineer, The Aluminum Castings Co., Cleveland

KER, HENRY W., Sales Manager, Wapakoneta Machine Co., Wapakoneta

WADSWORTH, HOWARD L., Manager, American Foundry Equipment Co., Cleveland

Pennsylvania

COHN, HERBERT A., Chief Draftsman, Works Power Engr. Div., Westinghouse Elec. & Mfg. Co., E. Pittsburgh

FERNSLER, PENROSE A., 135 So. 11th St., Lebanon

GODWIN, ROY M., Mechanical Engineer, Barrett Co., Philadelphia

LEROY, LEO F., Leading Locomotive Draftsman, Designer and Checker, Mechanical Department, Erie R. R., Meadville

OGLE, GEORGE M., General Engineer, Westinghouse Elec. & Mfg. Co., E. Pittsburgh

SEVERN, ARTHUR B., Equipment Pilot Engineer, Baltimore & Ohio R. R., Pittsburgh

Wisconsin

HAY, EARL D., Professor of Drawing and Machine Design, State Normal School, Oshkosh

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Colorado

BYERS, HARRY R., with Babcock & Wilcox Co., Denver

Connecticut

CARVETTE, CHARLES W., Military Engineer, Remington Arms Union Metallic Cartridge Co., Bridgeport

McGARVEY, JOSEPH T., Sub-Inspector of Ordnance Navy Dept., American & British Mfg. Co., Bridgeport

MAC INTYRE, JAMES R., Chief Designer, H. E. Harris Engineering Co., Bridgeport

District of Columbia

HATTON, MERLE W., Mechanical Expert, Chem. Warfare Service, Research Div., American University Experiment Sta., Washington

Illinois

PARMENTER, LAURENCE I., Private, Edgewood Plant, Edgewood Arsenal, Edgewood, Md., Detachment "D" Chicago & N. W. R. R., Chicago

SIMPSON, ARTHUR M., Sales Engineer, Wood Equipment Co., Chicago

WOOD, KENNETH V., Night Enginehouse Foreman, C. C. C. & St. L. R. R. Co., Mt. Carmel

Indiana

MENKE, EDWARD W., Assistant Engineer, United Chemical & Organic Products Co., Hammond

RETTERER, RAY W., Assistant Mechanical Engineer, C. C. C. & St. L. Rwy., Beech Grove

SMITH, DAVID W., Assistant Mechanical Engineer, Rubber Regenerating Co., Mishawaka

Massachusetts

NAKASHIAN, LUKE L., with Jefferies-Norton Corp., Worcester

PALMER, RAYMOND E., Chief Engineer, Construction Div., Kalmus, Comstock & Westcott, Inc., Cambridge

SODERBERG, ROBERT B., Lieutenant Ord. R. C., Army Inspector of Ordnance and Acting Quartermaster for Gray & Davis, Inc., Amesbury

WESLEY, HARRY B., Designing Engineer, Brown Bag Filling Machine Co., Fitchburg

New Jersey

KNOWLES, CHARLES H., Principal Assistant Engineer, The Arnold Co., U. S. General Hospital No. 3, Colonia

New York

CAHILL, JOHN E., JR., Ampudia & Cahill, Industrial Engineers, New York

FISHER, PIERCE H., in Charge Mechanical Development, Medical Research Laboratory, Mineola

McNULTA, J. JOSEPH, Chief Engineer, Vacuum Ash & Soot Conveyor Co., New York

RAYMOND, GEORGE G., Industrial Engineer, Gunn, Richards & Co., New York

SHELDON, WILLIAM M., Mechanical Engineer, Sheldon Co., New York

SMITH, EDWARD J., Foundry Engineer, Ingersoll Rand Co., Painted Post

SPICER, ELMER D., Factory Manager and Chief Engineer, Moore Steam Turbine Corp., Wellsville

THOMSEN, RAYMOND L., Manager of Marine Dept., The Griscom Russell Co., New York

Ohio

BOUGHTON, JAMES A., Chief Engineer Power House No. 2, Goodyear Tire & Rubber Co., Akron

CONSTAM, ALYN F., Construction Engineer, The B. F. Goodrich Co., Akron

CECIL, WILLIAM D., Resident Material Inspector, Baltimore & Ohio R. R., Cincinnati

MACLEAN, ARCHIE A., Engineer of Tests, Ordnance Dept., U. S. A., Standard Parts Co., American B. B. Plant, Cleveland

Oregon

BETHARDS, F. EARL, Efficiency Department, Willamette Iron & Steel Wks., Portland

Pennsylvania

EADES, HERBERT S., Assistant to Mechanical Engineer, American Bridge Co., Ambridge

RAPPAPORT, ARTHUR, Engineering Draftsman, John Lang Paper Co., Philadelphia

Wisconsin

ROBERTS, EARL H., Chief Mechanical Engineer, John Obenberger Forge Co., West Allis

Canada

JARRED, ARTHUR, Superintendent, Smithy, Massey, Harris Co., Ltd., Toronto

FOR CONSIDERATION AS JUNIOR

Connecticut

HOMANN, FREDERICK A., Ensign, Technical Duties, U. S. N. R. F. Dept., Public Works, Naval District Base, State Pier, New London

District of Columbia

BURDICK, THEODORE A., Sergeant 1st Class 437th Engineers, General Engineer Depot, U. S. A., Washington

FERNALD, ERNEST M. Laboratory Assistant Navy Yard, Washington

NOLAN, JAMES B., Warrant Machinist U. S. N., Bureau of Navigation, Washington

Illinois

CARMICHAEL, VICTOR V., Assistant to Superintendent of Power, Aluminum Ore. Co., E. St. Louis

KERR, VOLNEY A., Engineer, Draftsman and Designer, American Well Works, Aurora

SNAPP, HOWARD M., Jr., U. S. Army, A. S. S. C., Science and Research Div., Joliet

TYMESON, CHARLES P., 1st Lieut. Ordnance R. C., U. S. Army, Rock Island Arsenal

Indiana

CORNELL, DANA R., Assistant General Foreman, Heat Treating Dept., Standard Forgings Co., Indiana Harbor

McCRADY, HARRY E., Tool Designer and Checker, Nordyke & Marmon Co., Air Plane Eng. Dept., Indianapolis

Massachusetts

HOPKINS, ETHAN C., Superintendent, Wade Machine Co., Boston

RITCHIE, A. T., Draftsman, Simplex Electric Heating Co., Cambridge

Michigan

ALBINSON, HAROLD A., Machine Designer, Michigan Copper & Brass Co., Detroit

McKENNY, CHARLES A., Sergeant Mechanic, Co. C., 313 Field Signal Battalion, Ypsilanti

Missouri

BALCH, WILLIAM S., Secretary and General Manager, Southwestern Appraisal Co., Kansas City

WEISSBACH, EDWARD A., Mechanical Engineer, Mallinckrodt Chemical Works, St. Louis

New Jersey

COE, FRANK C., Superintendent and General Manager, C. T. Coe Co., Newark

NATHAN, WALTER S., Student U. S. N., Steam Engineering School, Hoboken

SKOOG, R. W., Draftsman, U. S. Navy Dept., N. Y. Shipbuilding Corp., Camden

New York

BERNNER, MILTON ST. J., Elmhurst

BEYER, EDMOND P. W., Designer, Gifford-Wood Co., Hudson

BUCHANAN, EDWARD E., JR., Heat Treatment, Curtiss Aeroplane & Motor Corp., Hammondsport

CARLISLE, CHARLES A., JR., with Savage Arms Corp., Utica

RIBEIRO, JOSE DE ASSIS, Calculator, American Locomotive Co., Schenectady

SIMS, LEWIS R., 1st Lieutenant, Ordnance R. C., Repair Shop Attach., 29th Div., Camp Mills, Mineola

SMITH, WILLIAM A., Assistant to Educational Director, The Texas Co., New York

STARLING, H. STANLEY, Assistant Material Inspector, Surveyor at Large, Bureau Veritas, New York

WALSH, HARRY W., Master Engineer, U. S. Army Engineers, New York

WALTON-CRANFORD, WILBERT, Erecting Engineer, Shipley Construction & Supply Co., Brooklyn

Ohio

GWIAZDOWSKI, A. P., Associate Professor of Mechanical Engineering, Toledo University, Toledo

LEATHERS, H. M., Sales Engineer, Cutler-Hammer Mfg. Co., Cleveland

Oklahoma

BROOK, CLIFFORD E., Assistant Supt., Gas Pipe Line Dept., Empire Gas & Pipe Line Co., Bartlesville

Pennsylvania

BODKIN, HARRY G., Tool Designer, Midvale Steel & Ordnance Co., Philadelphia

CANTER, MAURICE J., Production Engineer, Midvale Steel Co., Philadelphia

LEVIN, JACOB, Marine Draftsman, American International Shipbuilding Corp., Hog Island

SIPLEY, LOUIS W., Rate Estimator, Midvale Steel & Ord. Co., Philadelphia

SLICER, HARRY T., Assistant to Superintendent, Tyler Tube & Pipe Co., Washington

STINSON, JOHN A., Production Engineer, Midvale Steel & Ordnance Co., Philadelphia

Texas

SCOTT, FLOYD L., Engineer, Hughes Tool Co., Houston

Virginia

DOHERTY, CHARLES H., Jr., Assistant Testing Engineer, E. I. du Pont de Nemours & Co., Hopewell

Cuba

MURRAY, HAROLD B., Engineer, Sales Department, United States & Cuban Allied Works Eng. Corp., Havana

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

Alabama

CAINE, WILLIAM P., Steam Engineer, Ensley Wks., Tennessee Coal, Iron & R. R. Co., Ensley

Illinois

WILSON, JOSEPH B., Commercial Engineer, Westinghouse Electric & Mfg. Co., Chicago

PROMOTION FROM ASSOCIATE-MEMBER

Massachusetts

OLSON, MARTIN L., Instructor (Junior Master), Hyde Park High School, Boston

Ohio

HUNTER, SAMUEL R., Superintendent of Production, American Rolling Mill Co., Middletown

Washington

HAYS, LEWIS T., Tramway Engineer, U. S. Steel Products Co., Pacific Coast Dept., Seattle

PROMOTION FROM JUNIOR

Colorado

BISSELL, ALBERT W., Assistant Superintendent, Wire Mill, Colorado Fuel & Iron Co., Pueblo

Illinois

WACHS, THEODORE, Engineer, The E. H. Wachs Co., Chicago

Michigan

LANNING, JOHN G., Assistant to Vice-Pres., Detroit Lubricator Co., Detroit

Pennsylvania

BRAYTON, HAROLD M., Artillery Ammunition Designer, Frankford Arsenal, Philadelphia

GRAF, JOHN C., Material Agent, Southwark Foundry & Mch. Co., Philadelphia

ROSENCRANTS, FAY H., Purchasing Assistant, Emergency Fleet Corp., Philadelphia

Wisconsin

ALLISON, LAWRENCE M., Chief Engineer, Lawson Aircraft Co., Green Bay

REINSTATEMENT AND PROMOTION FROM JUNIOR

Georgia

McKEE, JOHN F., Engineer and Draftsman, General Fire Extinguisher Co., Atlanta

New York

PENDLETON, FRANK E., Chief Engineer, New York Steam Co., New York

Ohio

HORTON, WILLIAM M., Jr., General Superintendent, The Adams-Bagnall Elec. Co., Cleveland

Pennsylvania

MORRISON, EGBERT R., Estimating Engineer, Union Spring & Mfg. Co., Sharon

South Carolina

BARKLEY, MATTHEW B., Vice-President, Cameron & Barkley, Charleston

Wisconsin

KEOGH, JERE K., Erecting Engineer, Allis-Chalmers Mfg. Co., Milwaukee

SUMMARY

New applications	253
Applications for change of grading:	
Promotion from Associate	1
Promotion from Associate-Member	3
Promotion from Junior	7
Reinstatement and Promotion from Junior	5
Total	269

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any one desiring engineering services. The Society acts only as a clearing house in these matters.

GOVERNMENT POSITIONS

Stamps should be inclosed for transmittal of applications to advertisers; non-members should accompany applications with a letter of reference or introduction from a member; such reference letter will be filed with the Society records.

Members applying in person for Government positions at such places as Navy Yards should invariably make appointments beforehand by letter, telephone or telegraph, and arrange to have passes or the equivalents so that they can gain entrance. In this way they will avoid disappointment.

YOUNG MEN wanted for the Department of Military Aeronautics. Should have mechanical training and, if possible, be thoroughly grounded in electrical work. May be of draft age and will go as enlisted men, then assigned to Training School for Radio Mechanics and after instruction will be sent overseas. They will be inducted at once.

TECHNICAL MAN or one with several years' experience to act as assistant engineer of tests. Salary, $4 a day. 2625.

TECHNICAL MEN for the Navy with considerable engineering experience in large power plants, preferably married. Men who have been superintendents of repair plants desired. Not over 35 years of age. 2629.

MECHANICAL ENGINEERS especially experienced in machine-shop practice to act as chief inspectors for the Ordnance Department on shell machinery and automatic screw-machine work. 2633-A.

EXPERIENCED MEN also wanted on steel and forging work. 2633-B.

Men for above to be over draft age. Salaries for satisfactory men with considerable training from $2400 to $3000 per annum.

MECHANICAL ENGINEERS, experienced in ship construction to act as assistants. Salary, $2400 per annum. 2637

TECHNICAL MAN capable of making reports for technical journal. One with editorial experience necessary. Knowledge of wood desirable although not absolutely necessary. Maximum salary, $3500. 2640.

ASSISTANT in charge of research and development. Man to bring to stage of commercial production parts made of sheet metal, fabrics, rubber and die casting. Applicants must have personality to secure coöperation of manufacturers in development work along above lines. Salary, $3600 per annum. 2642.

PRODUCTION ENGINEER as superintendent of plant, or one who has had an execu-

tive position in manufacturing concern. Knowledge of rubber desirable but not essential. Man occupying this position would probably be commissioned. 2644.

CIVILIAN POSITIONS

MASTER MECHANIC, young, energetic, good tool designer and familiar with precision work and production methods. Man who has had experience with automatic and with precision grinding. Location Connecticut. 0445-H.

MECHANICAL LABORATORY ASSISTANTS AND DRAFTSMEN required for important war work in development of parts for sheet metal, fabric and rubber. Graduates from manual training schools with one or two years' shop experience or one or two years in an engineering school desirable. Enclose photograph, stage age, give references, position in draft and willingness to enlist or be inducted in the army for work of this nature. 0459-H.

SPLENDID OPPORTUNITY in an old-established business for practical man with combination of mechanical and business ability who understands sheet-metal and light-screw machine work; one who can also develop sheet-metal specialties to be marketed so as to afford volume production to the factory. Location New York. 0460-H.

ASSISTANT CHIEF ENGINEER to act as chief engineer during temporary absence of the latter. Work is in nature of quantity-production war work of the highest importance; in factory employing 2600, and large number of draftsmen; commands excellent salary. Location Brooklyn, N. Y. 0461-H.

ASSISTANT PROFESSOR OF EXPERIMENTAL ENGINEERING in an Eastern University; to have charge of classes for juniors and seniors in the steam laboratory and materials testing department and to give a course in kinematics to sophomores. Salary about $1500, depending upon previous experience. 0462-H.

TECHNICAL GRADUATE, mechanical engineer, preferably with one or two years' experience for power-plant lay-out and steam work. Salary $25 a week to start. Location New York State. 0463-H.

MECHANICAL ENGINEER with experience in design, testing and general engineering work in connection with small and medium steam turbines and their applications. Reduction-gear experience also desirable. Must have good business and executive ability and be able to handle a variety of work in connection with steam turbines and turbine-driven machines. Give full details of training, experience, salary expected and photograph. Location Connecticut. 0464-H.

DRAFTSMAN, power-plant equipment. Salary, $125. Location New York. 0466-H.

DRAFTSMAN on industrial and chemical plants. Salary, $150. 0467-H.

MECHANICAL ENGINEER with machine shop experience for position similar to master mechanic. Salary $50 to start. Location Brooklyn. 0468-H.

PROFESSOR OF MECHANICAL ENGINEERING in charge of department; should be technical graduate with both teaching and practical experience. Send full statement of training and experience, references and a late photograph. Salary $2400 for ten months. Location Idaho. 0471-H.

PROFESSOR OF ELECTRICAL ENGINEERING during period of war. Technical graduate preferably with teaching and practical experience. Send full statement of training and experience, references and a late photograph. Salary $2400 for ten months. Location Idaho. 0472-H.

INSTRUCTOR IN APPLIED SCIENCE LABORATORY, INSTRUCTOR IN ELEMENTARY APPLIED ELECRICITY AND MECHANICS for technical school in Greater New York. Preference given to men with mechanical or electrical technical training, with practical and teaching experience. Position permanent. Give full personal and experience data and photograph. State salary expected. 0473-H.

TECHNICAL TRAINED MECHANICAL ENGINEER, experienced in power-plant design, testing and operation. Location Connecticut. 0474-H.

MECHANICAL ENGINEER AND DESIGNER with extensive experience in design and construction of shipbuilding cranes, derricks, drag-line excavators and similar work. High-grade man wanted to take charge. Location Pennsylvania. 0475-H.

INSTRUCTOR in mechanics, mechanical drawing, mathematics, etc., for railroad-shop apprentices. Preferably a college graduate with some knowledge of railroad equipment and shop machinery. Salary $200. Location Texas. 0476-H.

INDUSTRIAL ENGINEERING PRODUCTION PROBLEMS. Opportunity for a man qualified by education to undertake work of this nature in large steel-castings plant. Preference given to man who has served apprenticeship in railroad shops. Location Ohio. 0477-H.

EXPERIENCED TOOL AND FIXTURE DESIGNER, with experience in the design of large machine tools. Essential industry. Location Central Ohio. 0478-H.

TIME-STUDY ENGINEER with shop-practice experience, draft exempt; time-study experience on automatic machinery desirable. Must have personality, diplomacy and tactfulness. Young man if possible. Salary $40 per week. Location New Jersey. 0479-H.

DRAFTSMAN with experience in the design of small engines. High-grade man. Salary $175 to $225. Location Pennsylvania. 0481-H.

DRAFTSMAN with experience on boiler design. High-grade man. Salary $175 to $225. Location Pennsylvania. 0482-H.

DRAFTSMAN with experience on locomotive-crane design. High-grade man. Salary $175 to $225. Location Pennsylvania. 0483-H.

DRAFTSMAN with experience on the design of steel towboats and barges. High-grade man. Salary $175 to $225. Location Pennsylvania. 0484-H.

DESIGNING DRAFTSMAN, acquainted with designing heavy machinery such as brass and copper rolling mills, hydraulic-press work, etc. Good designer and not an ordinary draftsman. Will make any reasonable inducement to the right man. Location Connecticut. 0485-H.

SALESMAN for special machinery. With technical training and also accustomed to meeting the engineering staffs of large organizations. Location Ohio. 0488-H.

YOUNG ORGANIZATION ENGINEERS, possessing both analytical and executive ability for time and motion-study work to standardize operations; large rubber plant. Large and expanding field for able men. Location Ohio. 0489-H.

PRODUCTION ENGINEER in newly organized planning department of large ice-making machinery plant. Location New Jersey. 0490-H.

MECHANICAL ENGINEER with sufficient experience to handle any design work in connection with the standardization of apparatus or its modification to meet specific requirements. Man with practical shop experience and technical training preferred. Will be subordinatae to engineer in charge of design and will have supervision over several assistants. Maximum initial salary $2400 a year, depending on the applicant's qualifications, etc. Location Brooklyn, N. Y. 0491-H.

ASSISTANT for checking all drawings against standards; accurate in work. Man with previous experience in this capacity preferred. Shop experience and technical training valuable assets but not required. Maximum initial salary about $35 per week. Location Brooklyn, N. Y. 0492-H.

SALESMAN, familiar with the steam-specialty business of the New York District. Position has every prospect of permanency and advancement. 0495-H.

SEVERAL FIRST-CLASS DRAFTSMEN with broad engineering experience wanted immediately. Good future for right man. Location Ohio. 0496-H.

THREE ENGINEERS, experienced in substituting mechanical equipment for hand labor. Must be familiar with all kinds of conveying equipment. Good future for right men. Location Ohio. 0497-H.

ASSISTANT MECHANICAL ENGINEER, familiar with general machinery in machine-shop and mill engineering. Must be competent to lay out and direct installation of new machinery, direct repairs and alterations on present equipment. Concern manufacturing mechanical rubber goods and employing about 2000. Technical graduate preferred. Salary $1500 to $2000, depending on man. Location Massachusetts. 0498-H.

MECHANICAL ENGINEER for production of airplanes; out of draft age or in Class 4. Salary $175. Location New York. 0499-H.

ASSISTANT PROFESSOR IN MECHANICAL ENGINEERING. Location Pennsylvania. Salary $1800. 0500-H.

ASSISTANT MECHANICAL ENGINEER with practical and theoretical experience and training in tool engineering; familiar with methods of manufacture for small, interchangeable parts. War work. Splendid opportunity for young man who can think and possesses unusual initiative. Location Brooklyn, N. Y. 0501-H.

MECHANICAL ENGINEERS AND DRAFTSMEN for designing machinery wanted by large and long-established company, located near New York City. 0502-H.

TURBINE DESIGNER of experience, capable of taking complete charge of design and construction of turbines and reduction gears, wanted by large and long established company, located near New York City. 0503-H.

TRAINED MECHANICAL ENGINEER with inventive ability to develop apparatus under the direction of chief engineer. Must have thorough grounding in theory of physics and mechanics. Only capable men of genuine ability will be considered. Give full details of training and experience. Location New York City. 0504-H.

YOUNG MAN WITH TECHNICAL EDUCATION and preferably some subsequent experience, for a steam-turbine manufacturer

mainly engaged in war work. State experience, draft classification, salary expected. Location Connecticut. 0505-H.

PRODUCTION ENGINEER, familiar with up-to-date production methods, particularly munitions production, heavy steel castings, etc. Salary about $6000 to $7000 a year. 0506-H.

INDUSTRIAL STATISTICIAN for Government work. High-grade man with salary in proportion to past records of results obtained. Man of draft age considered and if appointed would possibly be inducted into the Service. 0507-H.

MASTER MECHANIC to take charge of boilers, pumps, machinery and motors. Location New York. 0510-H.

MEN WITH TECHNICAL TRAINING or experience wanted for testing and efficiency work in power plants and substations of large electric-railway system. Good pay for men of adequate qualifications in the field of electric or steam-plant equipment. Give status with respect to draft. Location Brooklyn. 0511-G.

DRAFTSMEN, DESIGNERS, experienced in calculating and automatic machinery, typewriters, etc. Permanent positions to competent men. Location New York City. 0512-G.

PLANT ENGINEER of extensive and exceptional experience in plant engineering work, maintenance department, familiar with entire plant equipment, tools, jigs, die work, building construction, plant layout. Man of about 35 to 40 years of age. Location Philadelphia. 0514-G.

TEACHER for production work in connection with our coöperative courses in engineering; a man with actual experience in production and sufficiently broad experience to cover rather wide field. Salary $2400 or $3000 for three months' service. Location Ohio. 0515-G.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be on hand by the 12th of the month, and the form of notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

MECHANICAL ENGINEER, age 32, associate member, now employed as chief engineer of a plant making sugar, evaporating and heavy machinery. Experience of eight years in designing, estimating, purchasing and practical manufacture incidental to this class of machinery. H-207.

PRODUCTION OR WORKS MANAGER with specific training in all branches of shop, time-study and piece-rate efficiency and system, cost and general accounting, production and works management in metal stampings and fittings, tubing, general machine-shop and foundry-forging and die work, engine and general assembly. Available at short notice. Salary approximately $10,000. H-208.

EXECUTIVE OR PRODUCTION ENGINEER. Graduate mechanical engineer, 35 years of age, with 12 years' experience as an executive and in scientific management installations desires connection with manufacturing concern offering an attractive future as reward for hard work and results. At present employed. H-209.

PRODUCTION AND ENGINEERING EXECUTIVE with wide experience in the manufacture of interchangeable parts. Available September 15. Married, aged 30. In class IV of the draft. H-210.

MECHANICAL ENGINEER of executive ability, at present holding position but having little work to do; prefers to be busy. American, past draft age, married, technical education and 15 years' experience in industrial and power-plant work. H-211.

MECHANICAL AND MARINE ENGINEER, member, desires position of high responsibility, having upward of 18 years' experience in designing and operating large power plants and large ocean-going vessels. Will prove an expert on combustion and thermodynamics of either plant or ship. Will go where wanted. H-212.

FACTORY MANAGER OR ASSISTANT FACTORY MANAGER, with 30 years' practical experience and wide knowledge of mechanics in general. Twelve years in last position. Can furnish best of references. Well-informed on gas-engine work and also Liberty motor, with fair knowledge of heat-treating alloy steels. Readily adaptable to shop conditions. H-213.

WORKS MANAGER OR SUPERINTENDENT for manufacture of interchangeable parts. Experienced with large organizations and modern methods of operation. Graduate engineer with practical training in design, installation, operation and business administration. H-214.

MECHANICAL ENGINEER, college graduate, exempted from draft, experienced in sugar machinery and steam-power plant throughout Hayti, Santo Domingo, and Porto Rico, will consider a proposition to go to Cuba or Honolulu for the coming crop. H-200.

MASTER MECHANIC OR MAINTENANCE ENGINEER, member, now employed. Thorough technical and practical experience covering the construction, maintenance and operation of industrial works, steam- and water-power plants. Steam and fuel economy a specialty. Available about September 1. H-201.

MECHANICAL ENGINEER, member, thoroughly experienced in general mechanical and structural engineering; now in charge of engineering work on contracts aggregating twenty million dollars. Good organizer, executive ability, exemplary habits. Thirty-nine years of age. Will consider engineering sales proposition. Middle West preferred. Salary $5,000. H-202.

MECHANICAL OR WORKS ENGINEER, age 31, married, technical graduate, eight years' experience in design, construction and maintenance of paper mills and metal-manufacturing plants. Good organizer and executive. H-203.

SUPERINTENDENT OR MECHANICAL ENGINEER for cement plant, glasswork, porcelain or chemical works. Technical graduate, 39 years of age, married, 14 years' experience, able to handle tactfully executives and men; familiar with design, erecting and operating of crushers, dryers, kilns, furnaces, lehrs and grinding and labor-saving machinery. Can introduce methods of chemical control of raw material and finished product. Employed, but desires responsible position in a northern state. H-204.

SALES ENGINEER of high-grade experience desires a position as sales manager, sales engineer or plant manager; energetic salesman. Has travelled extensively and is well acquainted with machine and automobile manufacturers. Graduate mechanical engineer and good executive. H-205.

JUNIOR ENGINEER desires engineering or executive work with company situated in New York City. Mechanical engineering graduate of Worcester Polytechnic Institute, experienced in office executive work, good correspondent, and clear, rapid thinker, able to adjust himself quickly to new conditions. Is at present holding a civil service position in appraisal-engineering work. Married, exempt from draft, 25 years old and a junior member of the A.S.M.E. and S.A.E. H-206.

SALESMAN OR PURCHASING AGENT well versed in modern sales methods and systems, accustomed to meeting principals of large organizations, and estimating requirements to meet conditions. Has travelled extensively, thoroughly competent to complete contracts. Open for engagements after August 1. H-209.

MECHANICAL ELECTRICAL ENGINEER. 12 years' broad experience, technical training. Tactful executive, strong on coöperation, standardization and resource. Age 32, married. Specialty is design, development and production of small electrical equipment and other accessories with investigation of field for demand and requirements. Fully acquainted with modern factory methods and drawing office management, tool room and die work and finish processes. H-215.

ASSISTANT TO CONSULTING ENGINEER. Junior member, 1913 technical graduate, five years' practical experience in operating, testing and drafting in both electrical and mechanical engineering, four years with one concern, one year of power-plant drafting and heating and ventilating. Age 29, married, in Class IV, employed at present. Wishes a responsible position on the Pacific Coast. Salary, $150 per month. H-216.

FACTORY EXECUTIVE, experienced efficiency and mechanical engineer, in foundry practice, cotton and woolen textile machinery, machine tools, jigs and fixtures, oil mill, hydraulic, transmissions and wood-working machinery, is open for stable proposition offering adequate salary and ample authority. 35 years old. H-217.

CHIEF ENGINEER OR MASTER MECHANIC with thorough technical and practical experience covering construction, operation and upkeep of steel plant, specialty metallurgical work, heating and melting furnaces. H-218.

COMBUSTION ENGINEER, a graduate mechanical engineer, with 13 years' experience in the combustion of anthracite and bituminous coal, hand and stoker fired. Well trained in fuel-research work, sampling and the analysis of fuel. Capable of taking charge of the complete problems of a company consuming a large tonnage. H-219.

WORKS MANAGER, associate member, successful executive, experienced in design, purchase of materials and manufacture of general steel-plate work and allied lines, at present in complete charge of works employing 200 men, desires connection with a firm offering greater opportunities. H-220.

GENERAL MANAGER OR ASSISTANT TO PRESIDENT of a manufacturing company, desired by a resourceful and successful executive mechanical engineer in factory layouts, equipment and management. Complete record on request. H-221.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and Selected Titles of Engineering Articles

News of Other Societies

American Institute of Electrical Engineers

THE thirty-fourth annual convention of the American Institute of Electrical Engineers was held in Atlantic City, June 26 to 28. On Wednesday morning, the opening day, President E. W. Rice, Jr., delivered the annual address, taking as his subject, A Review of Electrical Engineering Progress. He called special attention to the work of engineers in connection with the war, and to the continued efforts which will be needed to carry on the processes of reconstruction after the war. After the close of his address he introduced President-Elect Prof. C. A. Adams, who responded briefly, touching upon the period of reconstruction which is bound to take place at the close of the war, and suggesting the possible need of altering or extending the scope of the activities of the Institute to the service which it can render to the nation and the world.

An important feature of the convention was the conference of Institute officers and delegates of sections and branches each convention day at luncheon, from 12.30 to 2.30 p. m. About fifty officers and delegates of sections met at these conferences.

On Wednesday afternoon, at the first technical session, the papers read dealt with various phases of transmission problems. The Thursday morning session was devoted to several papers on the general subject of protective devices. The papers were as follows: Lightning Arrester Spark Gaps—Their Relation to the Problem of Protecting Against Impulse Voltages, by C. T. Allcutt, of the Westinghouse Electric & Mfg. Co.; The Oxide Film Lightning Arrester, by C. P. Steinmetz, of the General Electric Co.; The Oxide Film Lightning Arrester, by Crosby Field, Ordnance Department, U. S. A.; and Design of Transpositions for Parallel Telephone and Power Circuits, by H. S. Osborne, of the American Telephone & Telegraph Co. Charles E. Stuart of the Power and Light Division of the United States Fuel Administration also outlined the plans which have been formulated by the Government to take care of the question of fuel supply and fuel requirements in order to conserve fuel necessary for the essential industries and for heating purposes.

On Thursday evening a highly interesting war session was held, opened by an address on Engineers and the War, by General William M. Black, Chief of Engineers of the United States Army. General Black gave a most vivid description of the work of the engineers in France, and exhibited several reels of moving pictures showing not only much of their detailed routine work, but also the enormous engineering construction works which have been erected at some of the French ports of debarkation. The balance of the session was devoted to papers on Electric Power for Nitrogen Fixation, by E. Kilburn Scott, Consulting Engineer, of London, and America's Power Supply, by C. P. Steinmetz.

Technical sessions were held Friday morning and afternoon, at which papers on miscellaneous subjects were presented in the field of electrical engineering. One of these of general interest to the engineer was on The Automatic Hydroelectric Plant, by J. M. Drabelle, of the Iowa Railway & Light Co., Cedar Rapids, Ia., and L. B. Bonnett, of the General Electric Co., Schenectady, N. Y.

American Society of Heating and Ventilating Engineers

The semi-annual meeting of the American Society of Heating and Ventilating Engineers was held at Buffalo, June 26-28. The rules for limiting the supply of coal to domestic consumers next winter were advanced to their final stages, and will now be submitted to the Bureau of Mines and to the Fuel Administration. Further progress was made in the society's plans to raise funds for the maintenance of a research bureau. Prof. J. E. Emswiler, of Ann Arbor, Mich., presented details of the methods used at the University of Michigan for testing radiators by electrical means, using an electric heater to generate the steam consumed by the radiator and determining the heat required by measurement of the energy consumed in the heater. Thomas Chester, engineer for the American Blower Company, reviewed the development of mine ventilation in this country. The amount of air used to ventilate a coal mine is usually from two to three times the weight of the coal mined, and the required volume is computed by allowing 150 to 200 cu. ft. per min. per man and 500 cu. ft. per min. per animal. He stated that from 10 to 30 per cent more coal can be mined in a thoroughly ventilated mine.

A session on drying was opened with a paper by W. A. Perry, who pointed out that the big problem of the Food Administration is not that of prices, but the distribution of the available food supply. H. C. Gore, chemist with the Department of Agriculture, described the recent progress made in the drying of vegetables, and referred to some of the principal advantages derived from this process: in the case of tomatoes the saving of freight amounts to 99 per cent; there is also an enormous saving of space. The department has developed a type of drier known as the *general purpose* dryer. Nathan Ovitz, of the J. P. Devine Co., spoke on the possibilities of the vacuum process in drying vegetables and fruits. While the initial cost of the apparatus is higher, the operating cost is low, and all danger of burning the product is eliminated. W. L. Fleisher explained his idea of using the heating and ventilating equipments in public-school buildings throughout the country for the drying of foodstuffs.

The afternoon session on Thursday was convened at the Buffalo Canoe Club, Abino Bay, where dinner was served later. In the first paper, Reasons for Failures of Heating Systems, J. D. Hoffman enumerated the conditions of poor building construction met by heating engineers and the restrictions placed on their work by the owners of houses who insist upon uneconomical installations of piping systems. In the paper next following, A Campaign for Fuel Economy in House Heating, C. W. Baker, recommended warm-air furnace heating, and urged the addition of an auxiliary cold-air duct by which the air supply to the furnace may be taken from inside the house, instead of from outdoors, during very cold or windy weather. Konrad Meier discussed Economy in Heating, basing his ob-

servations on his experience in Switzerland, where he is located. War regulations provide in that country that rooms should not be heated over 60.8 deg. fahr., and the heating of halls and stairways is stopped altogether. He favored intermittent heating by steam, and suggested the wider use of coke as a fuel in place of anthracite. In the final paper on Reforms in the Design of Hot-Air Heating Plants Needed to Compete with Other Systems, C. W. Baker presented the reasons why, by the use of intelligent methods in the design of a hot-air furnace plant, it can be made not merely the equal, but the superior, of either steam or hot-water heating for all buildings of moderate size.

At the closing professional session, on Friday morning, W. M. Franklin's notes on Spontaneous Combustion gave an exhaustive treatment of the principles of combustion, and indicated the two principal methods of preventing spontaneous combustion: either by enclosing the susceptible material in airtight, fireproof cans, or by spreading it in a thin layer freely exposed to the air. A Bulletin of the Bureau of Mines containing Notes on Spontaneous Combustion of Coal was read before the convention. The heating of the base hospital at Camp Dodge was also described in a paper by P. M. O'Connell. (Based on the report in *The Heating and Ventilating Magazine,* July 1918, pp. 27-42)

American Boiler Manufacturers' Association

The thirtieth annual convention of the American Boiler Manufacturers' Association was held on June 17 and 18 at Philadelphia, with M. H. Broderick, president of the association, in the chair. The association and guests were welcomed to Philadelphia on behalf of the mayor and citizens by Dr. E. J. Cattell, city statistician. Following Dr. Cattell's address, William H. Burr, president of the National Founders' Association, discussed informally the present industrial conditions and their relation to war work. D. M. Metcalf, chief inspector of steam boilers, Toronto, Ontario, described industrial conditions in Canada, especially as relating to shell making, shipbuilding and aeroplane building. Dr. D. S. Jacobus, of the Babcock and Wilcox Company, Mem.Am.Soc.M.E. Boiler Code Committee, treated at length the question of boiler-furnace design.

The work of the American Uniform Boiler Law Society in promoting the adoption of the A.S.M.E. Boiler Code was outlined by Charles E. Gorton, chairman of the American Uniform Boiler Law Society.

C. O. Meyer, deputy inspector of the State of Ohio, presented a communication from his department, pointing out that the A.S.M.E. Code does not include vertical-flue boilers and track locomotive boilers, and that as a consequence it had been necessary to make special rules for the former and use the rules of the Interstate Commerce Commission for the latter. He intimated that if such features were not covered by the Boiler Code Committee, Ohio might find it necessary to return to its own rules that were in force before the adoption of the A.S.M.E. Code, and he suggested that the chairman of the American Uniform Boiler Law Society should be a man who is neither a member of the A.S.M.E. Code Committee nor a boiler manufacturer.

A letter from the United States Board of Supervising Inspectors pointed out that their own inspection rules had been in use for sixty years, had met all conditions, were efficient and safe, and for those reasons the board declined to adopt the A.S.M.E. Code instead.

Charles M. Schwab, Director-General of the United States Shipping Board Emergency Fleet Corporation, declared that the situation regarding marine engines and boilers was critical; he said 80 or 90 hulls were already in the water awaiting power equipment. To meet the emergency, all manufacturers of boilers, engines and other ship equipment and accessories are being urged to increase their capacity as much as possible and make extensions wherever needed, with Government funds, which will be available for this purpose.

W. C. Connelly, of the D. Connelly Boiler Company, Cleveland, Ohio, was elected president for the coming year. (*The Boiler Maker,* vol. 17, no. 7, July 1918, pp. 190-197)

American Society for Testing Materials

The American Society for Testing Materials held its twenty-first annual meeting at Atlantic City, N. J., June 25 to 28. It was evident that there is an increased interest in specifications due to the great expansion in this field for war purposes.

The sulphur and phosphorus question in steel specifications was the only one that caused any difference of opinion, but a satisfactory solution was arrived at by the adoption of the following amending clause:

> In view of the abnormal difficulty in obtaining materials in war time, the rejection limits for sulphur in all steels and for phosphorus in acid steels shall be raised 0.01 per cent above the values given in the specifications. This shall be effective during the war and until otherwise ordered by the society.

This clause is to be printed under the title of each specification containing chemical requirements *except* those for boiler and firebox steel and those for boiler rivets. Further, as regards sulphur the note shall not apply to the specifications for carbon-steel car and tender axles.

Urgent war conditions led to preparing the single new specification, for cast-steel anchor chain. A threatened shortage in wrought chain led to active study in several iron works of the possibilities of cast chain, and highly successful results were obtained. The steel committee made tests of the new material and drafted specifications to govern its acceptance, which were accepted by the society as tentative. The steel for chain use, according to these specifications, is to be made in the electric furnace and produced in dry-sand molds or cores.

R. J. Wig, chief engineer, concrete ship division, Emergency Fleet Corporation, delivered an address on the concrete ship. He reviewed the progress of this industry and indicated that its permanency was assured. An interesting statement was that if the wooden ship is taken as 100, the relative weights of the concrete and steel ships are respectively 90 and 75. He felt assured that a cement has been developed recently whereby a lighter ship can be constructed, probably bringing down the ratio from 90 to 77 or 80 as compared with the steel ship at 75.

Dr. Henry M. Howe introduced a topical discussion on industrial research, and emphasized the vital importance of this subject to the nation's present and future welfare.

During the meeting the sad news was received of the death of the distinguished secretary of the society, Dr. Edgar Marburg, an account of whose life is given elsewhere in this number.

American Concrete Institute

The annual meeting of the American Concrete Institute, which was postponed from its regular time in February because of rail congestion, was held on June 27 to 29, at Atlantic City, N. J., simultaneously with the meeting of the American Society for Testing Materials.

Advantage was taken of this concurrence in providing for

joint meeting of the two societies, at which papers dealing with concrete were presented alternately by members of the two bodies.

One of the sessions was devoted to the subject of concrete ships and was illustrated by a number of moving pictures, showing among other things some of the operations in one of the United States Government concrete ship yards. The leading paper of this session was entitled Principles of Design of Concrete Ships, by R. J. Wig, chief engineer of the department of concrete ships, and S. C. Hollister, engineer of design. It was an excellent exposition of the details required in the design of ships, particularly of concrete ships, and outlined the study that the concrete ship department has made on the subject.

Another session was devoted entirely to the subject of concrete houses, and consisted of the presentation by the different members of the Committee on Industrial Concrete Housing of various papers taking up the several divisions of the housing problem. Lieut. K. H. Talbot gave full and valuable information on the different kinds of forms, methods of placing concrete and methods of finishing.

Papers on concrete tests were read at other sessions. J. L. Pearson, of the United States Bureau of Standards, gave in some detail the present status of the stucco tests being conducted by the Bureau.

The papers on design and construction included a complete analysis of a reinforced-concrete chimney by J. C. Mingle, a discussion of the stresses in eccentrically loaded reinforced columns by L. J. Mensch, and an analysis of the treatment of concrete surfaces by J. J. Earley, Washington, D. C.

Several important reports from different committees were submitted to the convention, as well as papers on the details of certain concrete structures.

Prof. W. K. Hatt, Purdue University, Lafayette, Ind., was reëlected president for the ensuing year. (From report in *Engineering News-Record*, July 4, 1918)

National Electric Light Association

The thirty-fourth annual meeting of the National Electric Light Association was held at Atlantic City, N. J., June 13-14.

President John W. Lieb, general manager and vice-president, New York Edison Co., in his address to the Association, pleaded for the continuation of teamplay in the electrical industries, in which he included street railways, telephone, telegraph, light, power and the manufacturing enterprises. He regarded the "linking up" of systems to further fuel economy as the most important problem now confronting the industry.

Samuel Insull, president, Commonwealth Edison Co., Chicago, suggested that relief from the burdens of high cost of conducting the industry could be had by applying for rate increases to the public-utility commissions. He urged that central stations drop extravagances of a capital character and of an operating nature.

P. B. Noyes, Director Conservation Division of the United States Fuel Administration, pointed out the work the administration was doing. America must mine 220 million tons of coal in excess of that ever before mined in one year, and the draft has taken away 35,000 coal miners. He stated that it was impracticable completely to cut off fuel to non-war industries. One ton of coal meant keeping at least fifty people at work. The Administration expects the utilities to do much of their own policing in respect to the economical use of fuel.

Dr. S. S. Wheeler made an address on training the blind to do work in the electrical industry. They are now successfully winding coils of stators and armatures at the same piecework rate paid sighted persons.

Charles E. Stuart, Chief of Power and Light Division, United States Fuel Administration, in his paper on War Conservation of Power and Light detailed the manner in which the Power and Light Division will carry out the general plans laid out for the conservation of light and power by the Bureau of Conservation of the United States Fuel Administration. Isolated plants will be eliminated. Shop committees appointed by the management of manufacturing and industrial establishments will have charge of all details in the operation of their plants that would in any way contribute to economy in fuel. Interconnection of the power systems of the country will permit the utilization of considerable excess waterpower which is at present available. In coöperation with the Joint Commission on Refrigeration, the Power and Light Division is planning to introduce a number of proved economies in the operation of ice and refrigerating plants.

W. W. Nichols, of the Allis-Chalmers Co., read a paper on The Development of Water Power as a War Measure. The 1,058,000 hp. of hydroelectric machinery built and installed in 1917 represented a saving of 8,500,000 tons of coal. Ten per cent of the estimated coal shortage of this year would be met if the industry could repeat that performance.

W. F. Wells, vice-president and general manager of the Edison Electric Illuminating Co., Brooklyn, N. Y., was elected president of the association. (Based on the report given in *Power*, June 25, 1918)

Society for the Promotion of Engineering Education

The twenty-sixth annual meeting of the Society for the Promotion of Engineering Education was held at Northwestern University, Evanston, Ill., June 26 to 29, with an attendance of 125 representing 40 institutions. The subject for discussion was Engineering Education and the War.

The War Department was represented by Drs. J. R. Angell, C. R. Mann and S. P. Capen. Dr. Angell spoke at length on the Committee on Education and Dr. Mann presented the final report of the Joint Committee on Engineering Education which was organized at the Cleveland meeting in 1907.

One of the most important subjects discussed was the question of attendance at engineering schools next year. Announcement was made of the modification of the Selective Service Regulations as follows:

> Under such regulations as the Secretary of War may prescribe, a registrant who is regularly enrolled in a school approved by the War Department Committee on Education and Special Training, and is pursuing full-time courses leading to a bachelor or higher degree in medicine, engineering, physics, chemistry, and other technical subjects essential to the prosecution of the war, or who is an indispensable teacher in such courses, or who is engaged in the training of Army personnel, may enlist in the Enlisted Reserve Corps, and thereafter on presentation by the registrant to his local board of his certificate of enlistment, such certificate shall be filed with his questionnaire, and the registrant shall be placed in Class 5 on the ground that he is in the military service of the United States.

Dr. Capen read a paper on the Relation of the Bureau to the War and to Engineering Schools. The report of the standing committees occupied practically one day. The Committee on Mathematics recommended that the society, through its executive officers, request the coöperation of the Mathematical Association of America toward the appointment of a joint committee for consideration of the entire question of teaching of mathematics.

The joint session of the Western Society of Engineers, the Chicago Section, A. S. M. E., the Chicago Section, A. I. E. E., and the S. P. E. E. on Thursday night, was a success in every way. A. S. Baldwin, chief engineer, Illinois Central Railroad, presided.

The society celebrated its 25th anniversary at this meeting. The following men were present who were at the organization of the society at the World's Fair in 1893: G. C. Anthony, Ira O. Baker, L. M. Hoskins, William T. Magruder, and S. N. Williams. They were called upon for addresses at the get-together meeting in the gymnasium on Wednesday night.

The institutional delegates sent the following telegram to the Secretary of War:

The institutional delegates present at the convention of the Society for the Promotion of Engineering Education express their hearty appreciation of the cordial relations which have existed between the engineering schools and the Committee on Education and Special Training of the War Department and offer their sincere coöperation in support of plans for the Student Army Training Corps.

The presidential address, Essentials in Engineering Education, was read by Vice-President John F. Hayford in the absence of President Milo S. Ketchum.

Committee on Development of the American Society of Civil Engineers

The spirit of the times for high ideals and greater service as now evidenced in all walks of life and business is reflected in resolutions adopted by the Board of Direction of the American Society of Civil Engineers, on June 18, 1918. The same spirit was shown in the discussion on the objects of an engineering society as the result of Mr. Cooke's paper on The Public Interest as the Bed Rock of Professional Practice, at our Spring Meeting at Worcester; and it is further attested in the principles enunciated by the Engineers' Club of Dayton, to which reference is made in another column of this issue. The significance of this spirit is indicated in the preamble preceding the resolutions relating to the American Society of Civil Engineers, the text of which follows:

The development and application of the sciences in recent decades have caused profound changes in the social and industrial relationships of all peoples.

The engineer has been a leader in this progress.

Sociological and economic conditions are in a state of flux and are leading to new alignments of the elements of society.

These new conditions are affecting deeply the profession of engineering in its services to society, in its varied relationships to communities and nations, and in its internal organization.

A broad survey of the functions and purposes of the American Society of Civil Engineers is needed in order that an intelligent and effective readjustment may be accomplished so that the Society may take its proper place in the larger sphere of influence and usefulness now opening to the profession.

Such a survey and readjustment can be accomplished successfully only with the aid of the membership throughout the country.

Any steps toward changes in organization must lead to a revision of the Constitution of the Society, which has not been materially modified for many years, during which the Society has grown rapidly and has established 22 Local Associations of Members.

The Constitution should be revised only after securing the views of the membership of the Society as to what its purposes and activities should be and as to the instrumentalities through which these purposes and activities should be carried out.

Any changes in organization must take into account all the conditions above indicated, and also the relationship of the American Society of Civil Engineers to other engineering organizations and to the public.

Therefore:

Resolved, That a committee be created to report on the purposes, field of work, scope of activity and usefulness, organization, and methods of work of the American Society of Civil Engineers, and to make recommendations concerning these matters; the committee to consist of one member chosen by each Local Association of Members, and seven members at large appointed by the President.

Resolved, That the President be instructed to select from this committee an executive committee of not less than five nor more than nine members and to appoint the chairman of this executive committee, who shall also be the chairman of the general committee.

Resolved, That the President be instructed to prepare a precept for the general guidance of this committee.

Resolved, That this committee be requested to present to the Board of Direction a preliminary report, not later than November 1, 1918, so that it may be printed and distributed to the membership in advance of the Annual Meeting in January 1919, at which meeting it will be presented for discussion.

Chicago Technical Societies Organize for War Work

Representing an effort to coöperate effectively and vigorously for war work, an important joint war committee has been formed by representatives of technical societies centered in Chicago. The movement was started by the military committee of the Western Society of Engineers, and at the invitation of that committee several meetings have been held at the Chicago Engineers' Club. As a result, the "War Committee, Technical Societies of Chicago," to quote the official name, was organized June 4, 1918.

The purpose of this organization is "to enable the technical societies of the Chicago zone to call into play the efforts of the members of the various societies herein represented as occasion may arise and to coördinate their activities in the most effectual manner to help win the war." It is not proposed to attempt any novel "stunts," but rather to place at the disposal of the United States Government and other authorized agencies the combined strength and resources of the Chicago technical societies for war work as need may arise.

The following member societies are coöperating in the new war committee:

Western Society of Engineers
Structural Engineers' Association of Illinois
Society of Industrial Engineers
Illinois Society of Engineers
Illinois Society of Architects
The American Railway Engineering Association
The Swedish Engineers' Society of Chicago
Illinois Chapter, American Institute of Architects
Chicago Section, American Society of Mechanical Engineers
Chicago Section, American Chemical Society
Chicago Section, American Institute of Mining Engineers
Mid-West Section, Society of Automotive Engineers
Illinois Association of American Society of Civil Engineers
Chicago Section, American Society of Heating and Ventilating Engineers
Chicago Section, American Society of Refrigerating Engineers
Chicago Section, Steel Treating Research Society
Chicago Section, Illuminating Engineering Society
Chicago Chapter, American Association of Engineers.

Officers of the war committee have been elected as follows: Chairman, F. K. Copeland; vice-chairman, W. L. Abbott; secretary, Edgar S. Nethercut; treasurer, William A. Fox. The executive committee consists of F. K. Copeland, W. L. Abbott, William Hoskins, C. A. Keller, Charles E. Lord, C. F. Loweth, Isham Randolph and Richard E. Schmidt. The address of the secretary of the war committee is 1735 Monadnock Block, Chicago. (*Official Bulletin*, June 22, 1918, p. 22)

War Work of Federal Board for Vocational Education

Since coming into existence one year ago the Federal Board for Vocational Education has organized its work in every state of the Union, and has rendered substantial assistance to the war-making branches of the Government through training men for special duties.

Under supervision of the board, war-emergency training classes for conscripted men have been organized in secondary schools and a series of war-emergency training courses has been prepared, not only for training under direct supervision of the board but in classes organized by the War Department among enlisted men and for classes conducted on a commercial basis under private civilian control.

Emergency war-training bulletins prepared by the Federal Board include announcements of training courses in shipbuilding for shipyard workers; mechanical and technical training for conscripted men (Air Division, United States Signal Corps); training for motor-truck drivers and chauffeurs; for machine-shop occupations, blacksmithing, sheet-metal working, and pipe fitting; for electricians, telephone repair men, linemen, and cable splicers; for gas-engine, motor-car, and motorcycle repair men; for oxy-acetylene welders; and for airplane mechanics, engine repair men, woodworkers, riggers and sheet-metal workers.

The preparation of these courses and the organization of training classes have been undertaken at the request of and in coöperation with the Signal Corps and the Quartermaster Corps in the War Department and the United States Shipping Board.

In June 1918, 12,000 men had been trained through the Federal Board and state authorities for vocational education and turned over to services—6000 in mechanical lines, 5000 in radio work for the Army, Navy and mercantile marine, and 1000 in clerical occupations for Quartermaster Corps work. It is estimated that an additional 3000 men have been trained by private agencies through impetus given to the work by the Federal Board, and that, when the complete reports for May are in, the number in training will be shown to be at least 7500. On June 13 the May reports showed 165 radio classes operated in 38 states and 172 mechanical classes in 49 communities distributed over 14 states. Contracts now in force provide for the training of 100,000 men during the current year. (*Official Bulletin*, July 17, 1918, p. 19)

Military Instruction Planned for College Students

In order to provide military instruction for the college students of the country during the present emergency, a comprehensive plan will be put in effect by the War Department, beginning with the next college year, in September 1918, in connection with institutions of collegiate grade. The details remain to be worked out, but in general the plan will be as follows:

Military instruction under officers and non-commissioned officers of the Army will be provided in every institution of college grade which enrolls for the instruction 100 or more able-bodied students over the age of eighteen. The necessary military equipment will, so far as possible, be provided by the Government. There will be created a military training unit in each institution. Enlistment will be purely voluntary, but all students over the age of eighteen will be encouraged to enlist. The enlistment will constitute the student a member of the Army of the United States, liable to active duty at the call of the President. It will, however, be the policy of the Government not to call the members of the training units to active duty until they have reached the age of twenty-one, unless urgent military necessity compels an earlier call. Students under eighteen and, therefore, not legally eligible for enlistment, will be encouraged to enroll in the training units. Provision will be made for coördinating the Reserve Officers' Training Corps system, which exists in about one-third of the collegiate institutions, with this broader plan.

This new policy aims to accomplish a twofold object: first, to develop as a great military asset the large body of young men in the colleges; and second, to prevent unnecessary and wasteful depletion of the colleges through indiscriminate volunteering, by offering to the students a definite and immediate military status. Those who do not graduate this spring should be urged to continue their education and take advantage of this opportunity to serve the nation.

Training camps to fit men to act as assistant instructors in the new Students' Training Corps are now being held at Plattsburg, N. Y., Fort Sheridan, Ill., and Presidio, Cal. Courses at these camps will end on September 16.

The character of the training given in the Students' Army Training Corps will depend on the kind of unit organized in the particular institution. The standard time to be allotted to military work will be ten hours per week during the college year supplemented by six weeks of intensive training in a summer camp. The ten hours a week will not include the hours of outdoor work in drill. The summer camps will be an important feature of the system. These will be active for six weeks, and there will be an intensive and rigid course of instruction. The plan provides approximately 650 hours of military work per annum.

Salvage of Waste Material Made Profitable in England

Consul Augustus E. Ingram, at Bradford, reports:

The National Salvage Council is now urging all local authorities to recover for utilization waste and dormant materials hitherto regarded as "refuse." A definite national use has been found for many of these articles, and by well-organized collections and proper treatment not only have national resources been conserved, but a reduction has been effected in the tonnage required for the importation of new raw material.

Conferences with municipal authorities have been held in various cities. In certain salvage operations, such as retinning old cans, large authorities could put down a plant that neighboring small authorities or townships could utilize. (The Director of National Salvage is about to issue particulars as to the best method for dealing with this material, so as to reclaim not only the steel, but also the tin and solder.)

The advice given at the beginning of the war to "burn all refuse" is now obsolete. For instance, waste paper, if properly utilized, saves a great deal of shipping. At present only one-third of the paper is returned for trade use, although 365 trades are absolutely dependent on paper. Some authorities are paying a bonus to their employees for bringing in waste paper from the refuse. In Shipley, 80 tons of waste paper were collected in 1917, and that, including rags, realized £641 ($3119). In Bradford last year 75 tons of paper were collected from various public departments in the city, and realized £430 ($2093). The pulping mills now established in the country are a valuable new industry.

A pamphlet has recently been issued to local authorities by

the National Salvage Council offering many suggestions on the collection and utilization of waste and dormant materials. Among other things it states that organic refuse is needed for the extraction of glycerine and for feeding pigs. Grease traps to save the grease from dish washing at hotels, etc., are suggested. All available bone material should be saved; at present only about half such available material is recovered. Fish waste should have the oil extracted and a meat food suitable for feeding animals and poultry made from the residue; at Liverpool a plant has been installed for this purpose, and the fats obtained find a ready sale at £80 ($389.32) per ton, while the meal is retailed at about £21 ($101.20) per ton.

The municipal destructor works at Bradford is doing excellent waste-reclamation work. Ashpit refuse, after the old cans and metal are sorted out, is utilized as fuel for operating the reclaiming machinery. The clinker from the furnace is ground into a coarse grit and sold for use in braking tramcars and fine ashes are utilized in the manufacture of disinfectant powder. Animal refuse is subjected to steam heat and disintegrated, yielding finally tallow, bone meal, and meat meal. (*Official Bulletin*, June 25, 1918, p. 16)

British Thermal Gas Unit Proposed as U. S. Standard

The Fuel Administration issues the following:

The proposed order of the United States Fuel Administration, making a universal British-thermal-unit standard of 528 in the manufacture of gas in the United States, was discussed at a conference held in the office of Mark L. Requa, director of the oil division of the Fuel Administration. Representatives of the public-utilities commissions of New York, Illinois, Pennsylvania, Maryland, New Jersey, Wisconsin, New Hampshire and Massachusetts were present, together with representatives of the War Department, Council of National Defense, and the war-service committees of the gas-making industry.

Mr. Requa explained that the purpose of the proposed order was to conserve oil; that the standard as adopted in the proposed order was the same standard as that now in effect in the State of Massachusetts; and that this standard was for all practical purposes the standard adopted by the French Government after an investigation extending over a period of years. The public-utilities commissioners present expressed themselves as being entirely willing to coöperate in the Fuel Administration's effort to conserve oil. Several of them requested the privilege of presenting suggestions in writing, which they thought would tend to make the proposed order more definite.

When the question of the price at which gas was to be furnished the public under the new standard came up for discussion, Mr. Requa said the public-utilities commissions of the various states should settle the matter for themselves—that the Fuel's Administration's principal interest was in reducing oil requirements to the minimum.

The proposed order would supersede all previous standards for candlepower and British-thermal-unit value in artificial gas. A British thermal unit is the amount of heat required to raise 1 pound of water 1 degree in temperature. (*Official Bulletin*, June 26, 1918 (p. 11).

Conference on Metal-Working Machinery

The War Industries Board announced today that the methods for increasing the output of plate-working machinery to meet the unusual demands, principally of the Navy and the Emergency Fleet Corporation, were discussed at a meeting of such tool builders with representatives of the War Industries Board, army and navy engineers, the Emergency Fleet Corporation and some of its sub-contractors. Probably 95 per cent of the manufacturers of punching and shearing machinery, bending rolls, plate planers, spacing tables, etc., were represented.

Suggestions for increasing the output included: more intensive manufacturing by eliminating the usual large variety of tools and concentrating on the production of a limited variety, and the distribution of contracts to concerns that have no urgent war contracts but which, with the aid of patterns, drawings and the coöperation of regular manufacturers, could produce standard equipment. It is hoped in this way to advance the general war program.

To carry out the suggestions adopted by the meeting a committee of manufacturers was appointed to work in conjunction with G. E. Merryweather, chief of the machine-tool section of the War Industries Board. This committee includes H. J. Bailey, of Hilles & Jones, Wilmington, Del., as chairman; W. R. Beatty, of the Beatty Machine & Manufacturing Co., Hammond, Ind.; W. H. Harman, of the Southwark Machine Co., Philadelphia; Walter D. Sayle, of the Cleveland Punch & Shear Works, Cleveland, Ohio; Fred C. Avery, of the Long & Allstater Co., Hamilton, Ohio. (*Journal of Commerce*, July 9, 1918, p. 3)

Lehigh University to Give Degree in Three Years

In order to meet the needs of the present war situation, Lehigh University will substitute, as a war measure, three-year courses in place of four-year as heretofore. By this means the student will gain one whole year of time in his life and save the cost of living expenses for one year without his being subjected to any serious additional strain in his work. By substituting three terms a year in place of two terms, and by shortening the summer vacation to one month, the University will be able to give the student the same course in three years that is now given in four.

Under the four-year system of two terms yearly of 17 weeks each, 34 weeks in a year, gave in the four years a total of 136 weeks, of which two weeks yearly, or eight weeks in the four years, were devoted to examinations, leaving 128 weeks for instruction. Without lessening the thoroughness of the different engineering and arts courses by introducing three terms of 14 weeks each, devoted entirely to instruction, 42 for the year, or 126 for the course, the work can be given in three years. This change involves the elimination of a little over two weeks yearly now given to final examination periods. Examinations will be taken care of by tests throughout the term. The proposed plan will allow one vacation of one week at Christmas and one of one week in the spring, with eight weeks in the summer, three or four weeks of which will be devoted to the required summer schools in practical work of the technical courses, leaving the men from four to five weeks' free time for rest and vacation—certainly an ample provision in this time of war strain, and perhaps at any time.

"Carry On" is the title of a new publication on the subject of the reconstruction of disabled soldiers and sailors. The magazine is a monthly message from General Gorgas, Surgeon-General of the U. S. Army, and published for him by the American Red Cross. It may be obtained without charge by addressing the Surgeon-General, U. S. Army, Attention Editor *Carry On*, Washington, D. C.

REVIEW OF ENGINEERING PERIODICALS

Aeronautics

The A. E. G. Bombing Biplane. Description, with illustrations, of one of the large German bombing planes. It is stated that judging from contemporary British standards of design the A.E.G. is, according to the official report, decidedly clumsy not only in detail work but also in appearance, while its performance is poor. Steel is used in construction to a very large extent while wood is introduced very sparingly and plywood is almost entirely absent. It is also quite inferior to the German Friedrichshafen machine as regards the useful load it can carry although the power plant is the same.

The following features of construction are of interest. The framework, possibly because it is made entirely of steel tubing, is formed as one unit from tip to tail. The cross and upright tubes of the framework are attached to the main booms by direct welding without the use of sockets, and single and double lugs are welded into the corners for the attachment of the bracing wires.

The method of carrying the engines is peculiar, the chief feature being the absence of any direct tie between the engine and the outer plane. In fact, the engines are supported entirely from the main spars of the lower wings with ties reaching out to the main booms of the fuselage. Each engine is supported from the front main spar by two pairs of V-struts meeting at a point and fixed to the spar by means of a ball-and-cup joint. A single pair of V-struts supports the engine from the rear spar, the connection with which is also made by means of ball-and-cup joint.

The one propeller which has been recovered has a diameter of about 10 ft. 4 in. and a pitch of 59.3 in. It is built up of ten laminæ, of which the first and tenth are of walnut, the second, third, fourth, sixth and ninth of mahogany, and the fifth, seventh and eighth of a different kind of mahogany, probably African. The thickness of the laminæ varies in a peculiar manner; the first is 0.73 in. thick, the second to the sixth are 0.80 in., the seventh and eighth 0.40 in., the ninth 0.80 in. and the tenth 0.83 in. thick. The official report surmises the enemy is either short of timber or has some highly scientific reason for varying the thickness, concerning which we have no knowledge. (*The Engineer*, vol. 125, no. 3258, June 7, 1918, pp. 484-486, 14 figs.)

Air-Propeller Performance and Design by the Specific-Speed Method, M. C. Stuart. The purpose of the paper is to develop and show a new method of treatment of the performance and design of geometrically similar air propellers. The method described is an adaptation and extension of methods which have been successfully applied to hydraulic turbines, centrifugal fans and centrifugal pumps; in particular, by the author in a paper on Centrifugal Fan Calculations by the Specific-Speed Method (*Journal of the American Society of Naval Engineers,* August 1916).

When the more usual type of propellers is applied to a machine the requirements of power and forward velocity of the machine are known and the rotational speed and diameter of the propeller are expressed in terms of power and forward velocity and the direct method of treatment is thus obtained.

The writer defines the specific speed N_s of a propeller operating at any given efficiency as the speed of a geometrically similar propeller which is of such a diameter D_s as to produce unit power at a unit velocity and with the same efficiency. Conversely, the specific diameter D_s of any propeller operating at a given efficiency is the diameter of a geometrically similar propeller which, when running at a speed N_s, will produce unit power at unit velocity and with the same efficiency.

The specific tip speed v_s of a propeller operating at any given efficiency may be defined as the tip speed of a geometrically similar propeller required to produce unit forward velocity at the same efficiency.

An interesting feature of the Specific-Speed method is the fact that the use of slip and slip function is not necessary.

The specific speed, specific diameter and specific tip speed of any type of air propeller, operating at any given efficiency, are defined as the speed, diameter and tip speed, respectively, of a geometrically similar propeller which will develop 100 useful (thrust) horsepower when the forward velocity is 100 m.p.h. Formulæ for these three specific units are derived from the laws of similitude as applying to propeller performance. From test data of any propeller of the type computations are made of the values of the specific units at various efficiencies; and the specific units and efficiencies are plotted in the form of curves, which, in connection with the formulæ, cover completely the design and performance of all propellers which are geometrically similar to the propeller tested.

It is believed that the presentation of the performance of propellers and the solution of problems by the Specific-Speed method may prove to be much simpler than the present methods which involve the use of coefficients and functions for the following reasons:

a The coefficients or functions are merely abstract numbers without any tangible significance, while the specific units used

in the Specific-Speed method may be thought of as speeds and diameters for unit requirements of performance, and the actual speeds and diameters for any requirements of performance are simply proportional to the specific units.

b All problems in the performance or design of a group of geometrically similar propellers may be solved by the use of a single curve and the simple formulæ for the specific units.

c The characteristics of various types of propellers may be compared upon coördinates which show directly the value of the propellers in meeting any desired requirements of performance. (*Journal of the American Society of Naval Engineers*, vol. 30, no. 2, May 1918, pp. 315-333, 5 figs.)

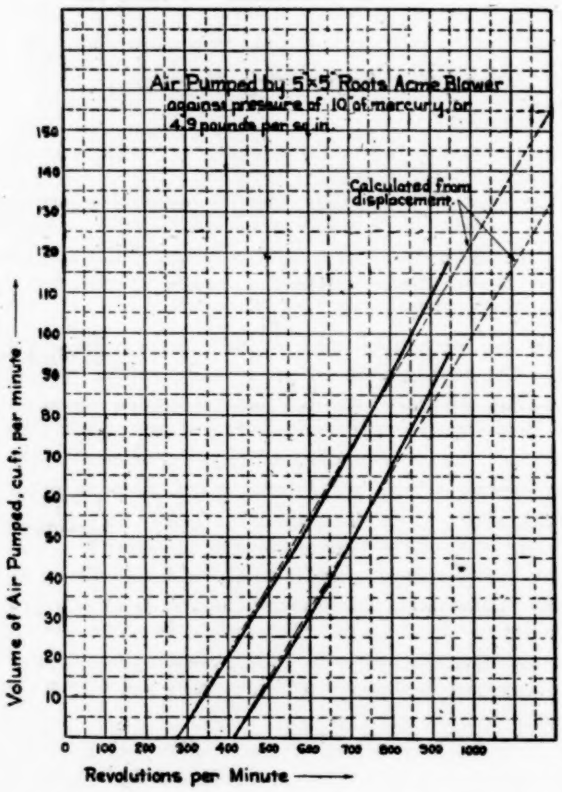


Fig. 1 Relation Between Quantity of Air Delivered and Speed of Blower

The Austrian Berg Single-Seater Fighter. The machine is of the single-seater fighter type, in which the pilot and top plane are so placed in relation to each other that the wing obstructs the view to a very small extent only. This has been accomplished mainly by making the body very deep and placing the pilot fairly high inside the body, the extra depth of the body being secured by deepening the turtle back which forms a very much greater proportion of the overall depth than is the case in most machines. The turtle back is different from the majority in that it does not, except in the front, cover the whole width of the flat top of the body, but comes to a point just in front on the vertical fin.

The pilot's seat is extremely comfortable and is provided with arm rests, enabling the pilot to rest one arm while working the control lever with the other.

The controls are mainly of the usual type, but, in connection with the lateral controls, the wing flaps are fitted with cranks recessed in slots in the planes; and there is a somewhat unusual arrangement whereby the *positive* cable is taken to the front arm of the crank, so that it is the *return* cable which pulls the wing flaps down. The reason for this may be found in the warped wing flap, which may conceivably have its outer tip tilted upwards to such an extent that the effect of moving the flaps is between a force acting downward on the flap moved upward before the flap on the opposite side which has been moved down simultaneously, receives an upward force.

Aerodynamically, the wings present an interesting feature. The upper surface of the wing section has a most decided return sweep beginning behind the rear spar and being of such a magnitude as to present a considerable area of concave surface.

The tail planes are built of steel tubing throughout and the fixed tail plane is of interest because of the fact that although it is built up of single steel tubes, the section is made cambered by bending the single tubes forming the ribs. Both upper and lower surfaces, therefore, have the same camber. The incidence of the tail plane is adjustable, but not during flight. (*Flight*, no. 491 (no. 21, vol. 10), May 23, 1918, pp. 555-557, 1 fig.)

Air Machinery

Tests on Rotary Blowers and Exhausters. Investigation of the effect of pressure drop due to friction in the intake pipe and of actual and probable delivery with varying speeds.

Tests on rotary exhausters are seldom performed, partly because their discharge is pulsating and therefore nozzles or orifices cannot be used to measure the flow directly, and also because the rotary exhauster is in itself a meter of the displacement type, its speed being the measure of the quantity of gas delivered.

Usually the probable delivery is found by multiplying the difference between the slip speed and the actual speed by the displacement of the exhauster per revolution.

There is a belief, however, that other factors enter into the rate of delivery, and, among other things, that the pressure drop due to friction in the intake pipe reduces the delivery and counteracts the increase in efficiency due to the higher ratio of actual speed to slip speed.

In order to clear up these points Prof. W. Trinks (Mem. Am.Soc. M.E.) undertook a test at the Carnegie Institute of Technology on the delivery of a Roots rotary blower. The results of this test are shown in Fig. 1, which indicates the relation between the quantity of the air delivered and the speed of the blower.

In order to get a larger slip the head plates were removed from the blower and more red lead was put into the joint. The right-hand curve was obtained from this test; the character of both curves being exactly the same, however.

The length and shape of the inlet pipe were varied and the location of the pressure gage on the outlet was changed, but none of these changes had any appreciable influence on the shape of the characteristic curves.

From these curves it appears that the actual delivery falls below the probable delivery at lower speeds and rises above it at higher speeds, which is probably due to vibrations of the air column. As regards these vibrations, it is stated that they have a phase lag against the impressed vibration of the blower, which may explain why attempts to furnish an engine torque of the blower have not been successful.

Vibrations occur in the discharge pipe as well as in the intake and increase with the speed, but only up to the point where they become sound waves. Above this speed the pitch of the sound, that is, the frequency of vibration increases, but the amplitude, that is, loudness, remains constant, the maxi-

mum depending upon the ratio of outlet-pipe size to fluctuation of displacement. The smaller the outlet pipe for a given blower the worse the vibration becomes. (*The Blast Furnace and Steel Plant,* vol. 6, no. 7, July 1918, pp. 298-299, 3 figs., *e*)

Engineering Materials

RUBBER SUBSTITUTES, Andrew H. King. Technical discussion of the factors and limitations to be considered in studying rubber substitutes. The writer believes that there is, as yet, no real substitute for rubber and states that oil substitutes are not in great demand in this country, because of the extensive use of reclaimed rubber and mineral rubber. He discusses the use of substitutes based on certain pitches, greases and waxes and briefly mentions the matter of glue substitutes. (*Metallurgical and Chemical Engineering,* vol. 18, no. 12, June 15, 1918, pp. 630-636, 1 fig., 7 tables)

USES OF ZIRCONIA AS A REFRACTORY. Abstract of a paper recently presented by J. A. Audley before the refractory section of the Ceramic Society (British).

The paper covers such matters as properties and composition of zirconia, its technical applications and as a lining for industrial furnaces especially, and the use of zirconia in the manufacture of ferrozirconium to be ultimately used for the production of zirconium steels. It was stated that these steels are particularly hard and it is affirmed that 1-in. armor plate of zirconium steel is equal to 3-in. armor plate of the best German steels. The matter of the manufacture of crucibles of zirconia was also discussed. (*The Iron Age,* vol. 102, no. 2, July 11, 1918, pp. 72-73)

THE EFFECT OF ANNEALING ON THE ELECTRICAL RESISTANCE OF HARDENED CARBON STEELS, I. P. Parkhurst. Paper read at the metallurgical symposium of the American Chemical Society in Boston, September 1917, in which the writer comes to the following conclusions:

The total change in resistance increases with the carbon content of the steel. The change is very rapid at the beginning of the annealing and becomes slower as the resistance decreases. However, there was no indication in any case that the change was complete at the end of the test.

Since the resistance of a steel changes with the hardness, the curves are a fair indication of the varying rates at which hardened steels are softened by annealing at a constant temperature. The larger part of the change is completed within a few minutes, but the change is not entirely complete in 113 hours. (*The Journal of Industrial and Engineering Chemistry,* vol. 10, no. 7, July 1, 1918, pp. 515-518, 3 figs.)

INFLUENCE OF SMALL QUANTITIES OF SOME METALLIC ELEMENTS ON THE MECHANICAL PROPERTIES OF BRASS, E. Millington. Description and data of experiments carried out to determine the effects of certain metallic elements on the mechanical properties of brass castings, the metallic elements investigated being tin, iron, manganese and aluminum. The addition of the first three elements to the copper-zinc alloy has been usually limited to 2 per cent, while manganese was carried to 2.81 per cent. In some respects the ternary alloys proved to have mechanical properties quite dissimilar from those of the original binary alloy. (*Journal of the Society of Chemical Industry,* vol. 37, no. 10, May 31, 1918, pp. 149 T-155 T, 3 figs., 3 charts, 2 plates)

SPECIFICATIONS FOR AIRCRAFT STEELS. Abstract of an address of Albert Ladd Colby at the last annual convention of the American Society for Testing Materials. Mr. Colby attended the Anglo-American and the International Aircraft Conferences, held in February and March, as the society's delegate, He stated that specifications were formally adopted and issued in April 1918 in the form of a pamphlet under the auspices of the British Engineering Standards Association, and gave some details of these standards. (*The Iron Age,* vol. 102, no. 2, July 11, 1918, pp. 70-71)

TESTS GIVE NEW INFORMATION ON CONCRETE BEHAVIOR. Abstracts of some of the papers presented at the joint meeting of the American Society of Testing Materials and American Concrete Institute.

Capt. L. N. Edwards, U. S. E. R., advanced the theory that the strength of cement mortars and consequently of concretes is dependent upon the quantity of cement in relation to the surface areas of the aggregates, consistency and physical qualities being equal. In other words, since the strength of mortar is primarily dependent upon the character of the bond existing between the individual particles of the sand aggregate, the optimum quantity of the cementing material depends upon the total surface area of the sand.

In fact, Captain Edwards stated that diagrams could readily be made showing the relation between granularmetric analyses of sands and their surface areas. To do this, actual counting of particles would have to be made at the beginning, but with these diagrams the proper quantity of cement for any given sand could readily be taken off.

P. J. Freeman, of the Pittsburgh Testing Laboratory, described the first year's results of tests of the five-year period of tests on the value of blast-furnace slag for a coarse aggregate in concrete.

In a paper entitled Fire Tests for Concrete Columns and based on tests made at the Pittsburgh Laboratories of the U. S. Bureau of Standards, Walter A. Hull, of the Bureau, indicates that the results so far obtained show beyond doubt that the design of a reinforced-concrete column, that is, the amount and disposition of the steel, is not nearly as important a factor in fire resistance as is the nature of the aggregate. It was further found that gravel-concrete columns showed a marked tendency in the concrete to break up early in the fire test.

Prof. D. A. Abrams, of the Lewis Institute, Chicago, showed through a series of elaborate tests that little additional strength can be attained by mixing concrete over one minute.

The same author presented a paper on the effect of age and storage on concrete strength. Data of many long-time tests taken from available literature showed a progressive increase in the compressive strength up to one, or in some cases, two years, with often a slight falling off beyond that period. When plotted to logarithmic curves, however, these showed a characteristic straight-line curve reducible to a formula with two constants, dependent on material, manufacture and storage.

To avoid certain difficulties with the standard Deval rattler when used for abrasive tests of road materials, Prof. H. H. Schofield, of Purdue University, has devised a modified rattler which is claimed to give a greater range of results. (*Engineering News-Record,* vol. 81, no. 1, July 4, 1918, pp. 48-49)

Internal-Combustion Engineering (See also Railroad Engineering)

EFFECT OF CIRCULATING-WATER TEMPERATURE ON THE LUBRICATING OIL. Data of tests recently made by the Texas Company for the purpose of determining the effect of the temperature of the water in the circulating system on the condition of the lubricating oil.

The motor used was a Buda-type H. U. which employs a forced-feed oiling system at an oil pressure of 30 lb., the oil reservoir holding eight quarts.

The first test was made with the entire radiator front blocked by a sheet of cardboard and the radiator filled with hot water. The second test was made by removing the cardboard and filling the radiator at the start with cold water. During the two tests the atmospheric temperature was quite low. A medium-bodied motor oil was used for both tests.

The prevailing idea as to the relation between the temperature of the motor and the character of the lubricating oil has always been that a hot motor thinned the oil down rapidly and that a heavier oil was required than for a colder motor. It appears, however, that when lower-grade gasolines and kerosenes are used and partially vaporized fuel passes into the cylinder, the liquid portions or heavy ends condense on the cylinder walls and tend to wash the lubricating oil off the cylinder walls. The test made with the circulating-water temperature of 180 deg. fahr. showed a reduction of viscosity of the oil of only 26.3 per cent, while similar tests made with a circulating-water temperature of 102 deg. fahr. indicated a reduction of viscosity of the remaining oil 48.3 per cent.

In the opinion of the author these tests show the bad effect on the lubricating oil of unvaporized fuel in the cylinder, and also show that even if complete vaporization is not secured through the carburetor the fuel loss may be reduced by the use of higher circulating-water temperatures. (*Lubrication,* vol. 5, no. 8, June 1918, pp. 11-14, 1 fig., *e*)

Machine Parts

ELASTIC COUPLING OF PRIME MOVERS AND GENERATORS, O. Ohnesorge (*Zeits. Vereines Deutsch. Ing.* 62, pp. 77-78, Feb. 16, 1918). In a previous article [Abs. 703 (1916)] the author pointed out that the oscillations of generating plant are set up not only by irregular driving moment, but also by the presence of elasticity in the coupling between the prime mover and generator. On this account the provision of elastic couplings to hinder any hunting of the units may exaggerate the trouble that is to be counteracted unless certain specific conditions are fulfilled. It is necessary that the coupling employed should have a definite elastic constant, but the proposal that all such couplings that are obtainable on the market should be classified according to this feature is hardly practicable. As a matter of fact, the couplings that are obtainable have in general far too low a power of storing energy. The present article describes with illustrations the main features of the design of an elastic coupling with adjustable elasticity and having the property of causing the forces to act on a comparatively large volume of the working fluid that provides the elasticity, a defect of most commercial couplings lying in the fact that there is not room within the coupling to bring sufficient working fluid into action. In the design shown the coupling consists of two parts connected together by pistons working in cylinders containing oil kept under pressure by connection with an air receiver to which the cylinders are joined by an oil-filled pipe passing through a hollow shaft. The elastic forces are able to be adjusted, even during running, by means of the pressure and volume of the air-receiver. (*Science Abstracts,* Section B—Electrical Engineering, vol. 21, pt. 5, (no. 245), May 31, 1918)

MAXIMUM POWER AND SPEED OF BELT PULLEYS AND GEAR WHEELS, W. Kummer (*Schweiz. Bauzeit.,* 30, no. 5, 1917; *Elektrot. u. Maschinenbau,* 35, p. 629, Dec. 30, 1917). The author investigates maximum practicable values for power and speed in belt pulleys and gear wheels, basing his results upon the maximum peripheral force, P kg., transmitted. In belt drives P depends upon the tensile strength of the belt referred to the maximum peripheral force which can be transmitted. Using quadruple Ideal leather, total thickness 16 mm., with large pulleys, favorable transmission ratio, and high belt speed, a force of $p = 55\text{-}56$ kg. per cm. of belt width can be utilized continuously. If the belt width $= b$ cm. $P = pb$. Let $q = b/D$, where $D =$ diam. in cm. of the smaller pulley, then the moment M in kg-cm. on this pulley $= D^2qp/2$. Introducing the revolutions per second n, and an experimental factor K (in cm./sec.^{2}), we have $D^2 = K^2/n^4$, hence $K^2/n^4 = 2M/qp$. Since the horsepower $L = 2\pi nM/7500$, we have $Ln^3 = \pi qpK^2/7500$. Taking the highest values which can be realized in practice without going to extremes, we have $p \sim 50$ kg./cm.; $q \sim 0.75$; and $K \sim 8000$ cm./sec.^{2}, which yields $Ln^3 = 1{,}000{,}000$ approximately. This equation is plotted in the original. In gear drives, the force P operative at the periphery is $P = kb^2/\psi$ where $b =$ width of gear wheel in cm., $k =$ experimentally determined coefficient of bending strength of the teeth of kg./cm.^{2}, and $\psi =$ ratio of wheel breadth to tooth pitch. By introducing the ratio $q = b/D$, the turning moment M in kg.-cm., is $M = D^3q^2k/2\psi$. Again, by introducing the revolutions per second (n), the constant K, and the horsepower L, we obtain the equation $Ln^5 = (\pi q^2kK^3)/(7500\psi)$, as expressing the relation between maximum power and speed for the smaller gear wheel. This expression appears also in the general form $Ln^5 =$ constant, as the general relation between power and speed in standard electrical machinery. According to American practice in ship driving, suitable values for the constant in the above equation are: $(k\psi) \sim 60/30 \sim 2$ kg./cm.^{2}; $q \sim 4.0$; $K \sim 53{,}000$ cm./sec.^{2}. Then $Ln^5 \sim 2 \times 10^{12}$.

The curves plotted between L and n for belts and gears from the above formulæ represent the virtual limits of present-day practice (say up to 5000 hp. for belts and 12,500 hp. for gears), assuming the same general construction in each type of drive from various horsepowers. Though these curves will change as practice advances, the general formulæ $Ln^3 =$ constant and $Ln^5 =$ constant will hold good for belts and gears respectively, so long as the appropriate factors are used in determining the constant term. (*Science Abstracts,* Section B—Electrical Engineering, vol. 21, pt. 5 (no. 245), May 31, 1918)

Machine Shop

SYMPOSIUM ON DROP FORGING. The fifth annual convention of the American Drop Forge Association was held in Buffalo, June 19 to 21, and in connection with this meeting was held the third annual meeting of the Drop Forge Supply Association. Numerous technical matters were discussed.

H. D. Savage presented a paper on Powdered Fuel for Drop-Forge Furnaces. He stated that powdered coal as now commercially developed is a practical, reliable and economical fuel for forge work. While it is not applicable to all existing plants, in those plants where it can be applied it may produce a fuel economy of 30 to 60 per cent over oil or coal burned by other methods, will increase production and greatly minimize the human element in the regulation of combustion. At the same time the author stated that he did not think the use of powdered coal was worked out very successfully in small shops because of the large expense involved in the installation. He also said that the American Locomotive Company is now using powdered-coal furnaces at its Schenectady plant and is equipping its whole forge shop with them. These furnaces are

being provided with stacks and forced draft to exhaust the ashes, and dust that formerly escaped into the shop is now kept in the furnaces and carried up the stack.

B. K. Read presented an interesting paper on Fuel Analysis of the Drop-Forge Plant. In it he pointed out the fact that a vast majority of manufacturers are still burning their fuel under conditions not conducive to the greatest possible economy. This applies not only to the case of coal, but to oil burning as well. He cited a case of one company where the following arrangement is used:

The company has an oil storage capacity of 120,000 gal., approximately a month's supply, in seven storage tanks. The oil house is connected with the steam-drop-hammer shop by a concrete tunnel in which are located the steam and oil lines. A duplicate system of motor-driven circulating oil pumps is located in the steam-hammer house, distributing the oil around the building in the steam-pipe tunnel, then to the board-hammer shop, and then overflowing back to the oil house. A pressure of about 20 to 30 lb. is maintained. From this circulating oil line risers are taken up to the various furnaces. A natural-gas line parallels the oil system so that either fuel may be used. Supplementing the oil-line system is a test oil line. A 300-gal. test tank is located in the oil house and a circulating oil line extends around the shop with a plug tee at each furnace. This enables any one furnace to be tested independently of the main oil supply. A test gas meter is provided for use in making tests when both gas and oil are used. Along with the oil and gas system is the air-pressure system. Air is delivered by a centrifugal compressor at 16 oz. pressure to five mains and then to each furnace.

The furnaces are built to withstand shocks and vibrations, and are completely encased in a steel box lined with firebrick. No induced air is allowed to enter the furnace. The slag opening is normally closed, and the only escape of the products of combustion is over the hearth. Above and in front of the hearth is a perforated air pipe deflecting the gases upward. In the upward path of the waste gases is placed a cast-iron pot or preheater through which the pressure air passes over baffles and is heated before it mixes with the oil and gas. Four sizes of furnaces are used and a spare one of each size is provided.

Tests carried out in this plant have shown a very material economy in fuel, due to the improved method of operation. Thus it was found that the furnaces were burning about as much oil during meal hours and the time between shifts as when there was steel in them. As a result, two men were assigned to watch the furnaces and shut them off during these periods. The air pressure is also a factor in furnace economy requiring an investigation of the air line.

George W. Pressell presented a paper on the relation between the highest quenching speed and maximum hardness. He stated that for hardening purposes an oil should be selected which will give a uniform quenching speed, will not produce gaseous vapors at low temperature, and will not oxidize or thicken with repeated use. The quenching speed of an oil depends on its refrigerating properties and also on its fluidity or viscosity.

He stated that exhaustive tests were made with an animal hydrocarbon oil which is a distillation of wool grease (no further data as to this oil appeared to have been presented) claimed to be an oil possessing a smaller percentage of residue and solid matter in suspension than any other oil known.

The average quenching speed for distilled wool-grease oil was 102 sec. The total variation in time of quenching in temperature of the bath ranging from 82 to 249 deg. was 9 sec., while cottonseed oil under the same conditions showed a quenching speed varying from 104 to 119 sec.

The ideal quenching medium for forgings would be a water-soluble material, which, when mixed with water, would give a quenching speed through the critical range equivalent to that of water, and from the critical range to the atmospheric temperature equivalent to that of oil. Mixtures of water and oil proved to be unsuccessful, however.

George C. Stebbins discussed the Care and Maintenance of Piston Rods. It is at present regarded necessary to use the highest grades of steel in piston rods, and the author found that his greatest trouble was caused by breakages of piston rings.

Referring to the maintenance of hammers, he recommended the use of a central oiling system, and explained a system of this type that he has installed in his plant. A steel tank is located near the steam line, a pipe running from this line into the oil tank to secure the proper pressure. The oil is carried in a line from the pressure tank, from which it is fed to the hammer. A $\frac{1}{2}$-in. line carries it to an ordinary sight-feed lubricator, and there is a $\frac{3}{8}$-in. line above the lubricator, which taps into the throttle. The system is so arranged that the oil supply for any hammer can be shut off. He said that in his plant many of the piston rods that are used had heads riveted on instead of using the solid rod, and he found this type of rods satisfactory. (Abstract made through *The Iron Age,* vol. 101, no. 26, June 27, 1918, pp. 1650-1654, *dp*)

MANUFACTURE OF CAST-STEEL CHAINS, Chester K. Brooks. Description of the work of the National Malleable Castings Company in the experimental development of cast-steel chains.

The first problem was the working out of suitable foundry methods for producing chain links in sand molds and uniting them into continuous lengths of chains.

Because of the vital importance of sand castings in a product of this character all of the links are produced in dry-sand molds. The method of application of gates and risers required some study, but it is said that excellent results were obtained both in pouring through the stud and through the side of the link.

The article describes in some detail the methods of testing the product by both dynamic and static tests. The results of these tests are given in the form of tables.

The second part of the paper is devoted to a discussion of the design and manufacture of the M. C. B. coupler.

The limitations of the M. C. B. contour have imposed certain fixed dimensions upon the size of the hub of the knuckle, its weakest point, and have barred any substantial increase in section. At the same time the stress to which this hub is subjected is enormous. It was believed that the use of a material of high ductility would be capable of withstanding these severe shock stresses, as it was supposed a very ductile material would by its elongation absorb some of the shock and so save itself from rupture. The difficulty with this is that the major part of this elongation is available only after the elastic limit of the material has been passed.

Two possible solutions for this problem have been offered: one, a change in the contour of the knuckle, approved some years ago by the M. C. B. Association; and the other, the development of a new steel.

The author states that the experience gained in the manufacture of the coupler knuckle has been extensively utilized for development of the cast-iron chain. In this connection he believes that the standard M. C. B. drop-testing machine presents the most readily available machine for testing cast-steel chain links. (Paper read before the American Society for

Testing Materials, June 25-28, 1918, abstracted through *The Iron Trade Review,* vol. 63, no. 1, July 4, 1918, pp. 29-32, 19 figs., *gd*)

EFFECT OF MASS ON HEAT TREATMENT, E. F. Law. The usual method of experimental work on heat treatment of metals involved using test pieces of comparatively small size. Unfortunately, however, the heat treatment of large masses of steel presents many difficulties not met in the case of small masses. As a result some of the troubles in commercial heat treatment are due not to the lack of knowledge of the underlying phenomena, but to not always correct practical application of that knowledge.

The present investigation had for its purpose the obtaining of information which would enable one to understand the changes which actually take place in a considerable mass of steel during the stages of each treatment.

In this case the experimental cubes were 18 in. on a side, weighing 14.5 cwt.

These cubes, supported on knife edges, were heated in a gas-fired "treatment" furnace in which the flame did not come in contact with the cube. The cube was gradually raised to the temperature of 1650 deg. fahr.

The curves in Fig. 2 show the heating of these cubes. One of the most noticeable features about these curves is the rapidity with which the heat penetrates to the center of the cube. At 130 min. from the time of charging the center and half-way are almost at the same temperature, but at this point the absorption of heat due to the Ac change causes greater lag at the center than elsewhere and the two temperatures do not approach one another again till the lapse of another 70 min.

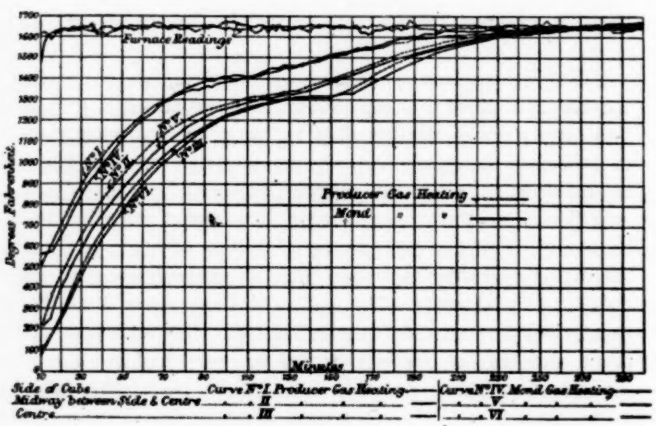


FIG. 2 HEATING CURVES OF STEEL CUBES 18 IN. ON THE SIDE

After being in the furnace for about 4½ hours the cube is withdrawn and cooled one way or another. For air cooling it is placed on knife edges; for oil cooling it is plunged in the usual way in mineral oil having a specific gravity of 0.897.

The comparative cooling curves are given in Fig. 4. The rate of cooling with oil seems to have been surprisingly rapid in this test, due evidently to the fact that a very large volume of oil as compared with that of the metal was used.

A third cube was placed on knife edges and cooled by spraying water at a pressure of 10 lb. per sq. in. on the upper and lower surfaces.

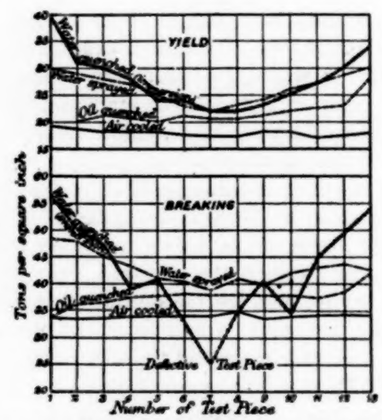


FIG. 3 DATA OF MECHANICAL TESTS OF SAMPLES FROM CUBES COOLED IN VARIOUS WAYS

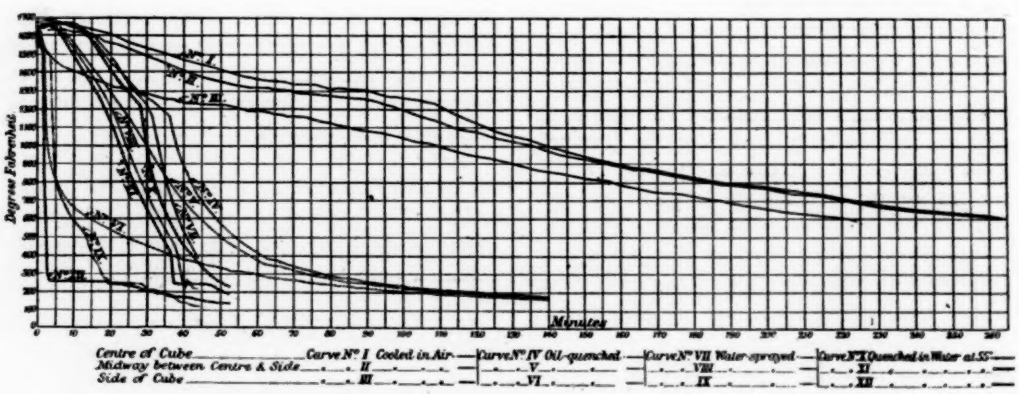


FIG. 4 COOLING CURVES OF 18-IN. STEEL CUBES IN AIR, OIL AND WATER

It is of interest to compare the oil and water curves. With oil—even in the center of the cube cooling takes place rapidly; but the evolution of heat at the Ar point is very noticeable. In the half-way curve, however, there is not the slightest indication of any recalescence. If it occurs (and presumably it does) it appears to be so evenly balanced by the conduction of heat to the outside that no change in the direction of the curve is noticeable. In fact, if the half-way curve were considered by itself it might be supposed that the steel possessed no critical point at all.

The curves VII, VIII and IX secured with water are in some respects similar to the curves with oil. The center curve again shows an evolution of heat and is not unlike the oil-hardening curve, although the rate of cooling through the lower ranges of temperature is more rapid. On the other hand, the half-way curve is totally different to that obtained by oil quenching. There is no sign of recalescence in the upper ranges, and the temperature falls evenly until about 450 deg. fahr. (232 deg. cent.), when there is a sudden acceleration in the rate of cool-

ing, followed by an abrupt halt at about 250 deg. fahr. (120 deg. cent). Somewhat similar features are shown in the curve representing the cooling of the outside of the cube.

The important difference between the two methods of cooling is to be found in the almost sudden slowing up of the cooling in oil shown in the lower ranges of temperature as compared with the cooling in water. Both in oil and water cooling, however, there is a period during which the metal in the center of the cube is cooling down more rapidly than the metal midway between the center and the surface.

A mechanical and photomicroscopical investigation of the metal was also carried out. The results of the mechanical tests are plotted in Fig. 3.

As might have been expected, the 13 results from the air-cooled cube gave practically identical results. In the case of the oil-quenched cube the breaking stress and yield are both raised, while the elongation is lowered, to almost the same extent in every test, the curves approaching a straight line. In other words, the effect of oil quenching is as apparent in the center of the cube as on the outside. In contrast to the results obtained by oil quenching, those obtained by water quenching show a very decided variation from surface to center of the cube; and this is most marked in the case of the cube plunged in cold water. The effect of the quenching is uneven, and the tests suffer from the lack of what might almost be described as "automatic tempering," which occurs in the lower ranges of temperature during oil quenching.

Sections were cut from the test pieces and examined microscopically. The photographs obtained show the characteristic appearance of magnifications of 100 diameters. The entire series are pearlitic, as might have been expected from the mechanical tests, and under higher magnifications they all, with one exception, show well-developed laminated pearlite. The exception is to be found in the surface of the cube quenched by plunging in water. In this case very little free ferrite is to be seen, and it is evident that the transformation has been very nearly arrested. This is confirmed by the fact that the surface of the cube was the only part which presented the slightest difficulty in machining.

The abrupt halt in the neighborhood of 250 deg. fahr. (120 deg. cent.) shown in the curves obtained from the water-cooled samples was totally unexpected and too striking to be passed over without notice. The writer does not claim to give an explanation of this fact, but points out that experiments repeated on 18-in. and 12-in. cubes showed that it occurred with remarkable regularity and was not affected by reasonable variation in mass. (Paper read before the Iron and Steel Institute, May 3, 1918, abstracted through *Engineering*, vol. 105, no. 2736, June 7, 1918, pp. 647-650, 2 figs., *eA*)

Steels for Gears and Their Treatment, Geo. A. Richardson. The writer divides all gears into two classes:

a Gears which are primarily used merely for the purpose of changing speeds, and

b Gears which are primarily used for the purpose of conveying power and must withstand the severe service conditions which are necessary.

In the first case, the cheapest material consistent with convenience is the best; in the second, the best material is the cheapest.

When the gears are to be used to convey power it becomes necessary to consider:

a Whether resistance to wear is the most important requirement, or

b Whether the resistance which the gear will offer to shock or sudden and excessive loads is of importance.

When resistance to wear is the most important consideration, the oil-hardened gear will, in the opinion of the author, give better service than case-hardened material. This opinion is rather contrary to the generally accepted view, and is based on the consideration that case-hardened material has an excessively brittle surface, and lacks the strength and toughness necessary to withstand the impact of shocks or heavy and excessive loads.

It was formerly believed that superior results could be obtained in gear trains by using varying grades of materials in the different gears, the idea being that those gears which tended to wear out fastest should be made of harder or better material. The latest information shows that when gears are operating under the same service conditions no advantage is secured by using gears of varying hardness.

As regards material, cast iron is the best material where it can be used, but all heavy gears for high, severe service have to be made of cast steel of either the straight-carbon or alloy types. While such gears can be cast in varying sizes for quantity production, drop forgings are preferable because they are cheaper to make, more uniform and stand up better in service.

For especially severe service, large-size gears have been manufactured with great success by using a nickel-chrome composition and air-hardening. In alloy steels for gears there are two general classifications to consider; case-hardening and oil-hardening. In some cases the choice between the two classes is determined by certain definite considerations. In many other applications, either class may be used. Plain carbon steel is used quite extensively in the case-hardened form, but not for the more severe kinds of service, because the core is very low in tensile strength.

An important point to bear in mind in connection with alloy-steel gears is that the lower the quenching temperature that can be used to get an effective hardness, the better the result. The higher nickels can be successfully hardened at the lower temperature. Chrome-nickel steels require a somewhat higher hardening temperature which decreases as the nickel content increases. Chrome vanadium requires the highest quench of all. For case-hardening it is not well to go above 0.20 per cent carbon in any of the alloys.

The alloy steels will stand a forging temperature of as high as 2200 deg. fahr., but they must be finished at a low temperature, the finishing temperature being the more important the higher the grade of steel.

The writer discusses in detail the case-hardening of high-grade steels.

As regards oil-hardening alloy steels, the writer states that the more sensitive of them, such as nickel-chrome compositions, absolutely require a double treatment. The first requirement is a preliminary treatment which may be a quench or an anneal to break down the crystallization set up during forging and bring the steel to a uniform cell size, though not a thorough grain refinement. In addition, it has been found desirable in the case of some alloys to give them a quench from the forging temperature in order to improve the condition of the steel. The forgings are taken directly from the forge and dipped into oil or water. They become black, but not cold and are then buried in ashes. The final treatment should be given at the lowest temperature that can be used and still give hardness.

As regards the relative merits of case-hardening and oil-hardening compositions, the writer states that, as a general

rule, the oil-hardened gear can be counted on for more steady and uniform wear. Oil-hardened gears give a lower scleroscope hardness than case-hardened gears, but this is not a criterion of wearing quality, as the toughness of the material always enters in. (Paper presented at the Annual Meeting of the American Drop Forge Association, June 20, 1918, abstracted through *The Iron Age,* vol. 101, no. 26, June 27, 1918, pp. 668-670, 2 figs., *gp*)

Machine Tools

AUTOMATIC SPACING AND PUNCHING MACHINE FOR STRUCTURAL WORK, S. A. Hand. Description of a new machine which automatically spaces and punches variable structural members in both web and flange in one passage through the machine, and in any lengths and widths up to the maximum delivered by the rolling mills. All motions are electrically controlled from a central keyboard in about the same manner as musical instruments are played. (*American Machinist,* vol. 49, no. 1, July 4, 1918, pp. 1-8, 11 figs.)

HIGH-CUTTING-SPEED PLANER. The Powell Machine Company of Worcester, Mass., has developed a metal-planing machine claimed to give high cutting speed. This latter is secured by providing for accelerated platen travel after the cutting action is begun.

High speeds are difficult to secure in a planer because of the following factors: (1) the shock caused by the reversal of the platen at the return of the back stroke, and (2) the impact of the tool striking the work at high speed.

In the Powell planer automatic means are used to allow the tool to enter the cut at a low speed and to increase this speed thereafter.

On the usual driving shaft there are provided a pair of tight and loose pulleys for a return speed of 120 ft. per min., and a pair of tight and loose pulleys for a cutting speed of 60 ft. per min., in addition to which the planer is equipped with a second driving pulley and connections which increase the speed of the driving shaft to 180 ft. per min.

As the table reverses to take the cutting stroke the cutting speed is shifted to the tight pulley, which is provided with a ratchet. The tool now enters into the cutting stroke. After the platen has moved a predetermined distance a dog attached to the platen shifts a belt to the secondary high-speed pulley. This increases the speed of the driving shaft, which unlocks the ratchet pulley. By an arrangement of dogs placed at predetermined positions it is claimed that the cutting speed may be increased or retarded without perceptible shock or strain to moving parts during the cutting stroke. At the end of the stroke the final dog shifts the belts back to the loose pulley and the return is shifted to the tight pulleys. This causes the platen to return at normal speeed. (*The Iron Trade Review,* vol. 63, no. 1, July 4, 1918, pp. 22-23, 1 fig., *d*)

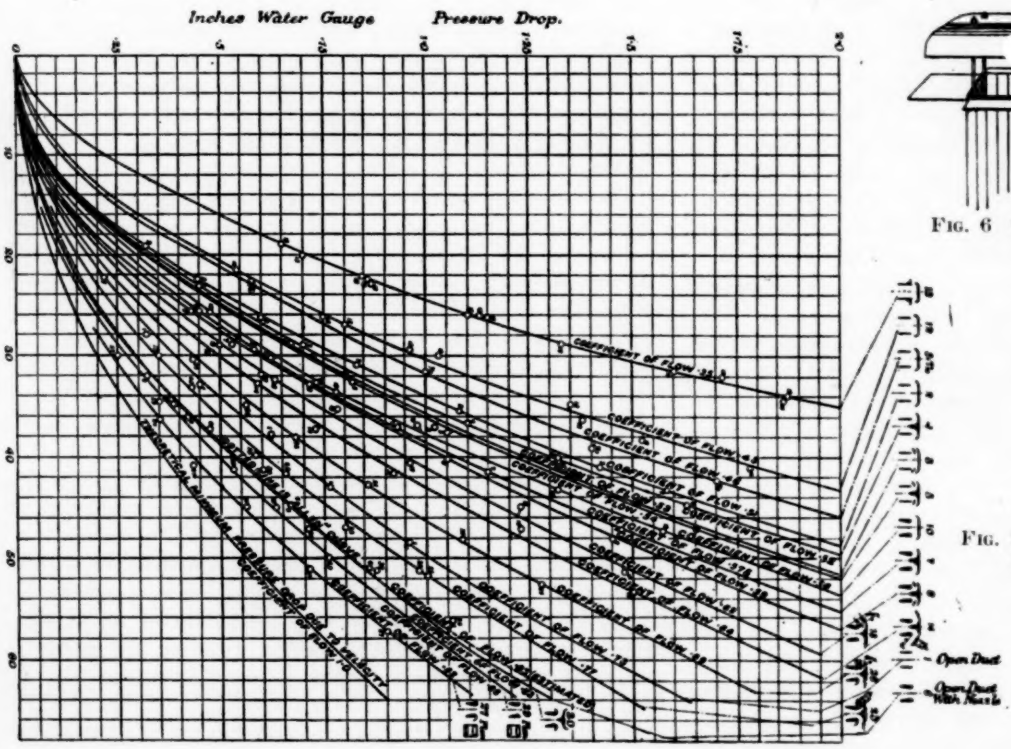


FIG. 5 TEST RESULTS WITH VARIOUS INTAKES: SHAFT OF SQUARE SECTION

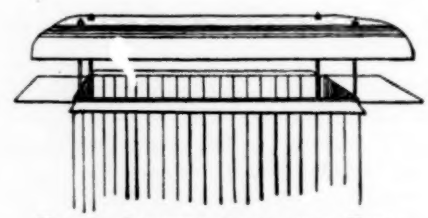


FIG. 6 OLD-TYPE COWL WITH FOUL-WEATHER FLAPS

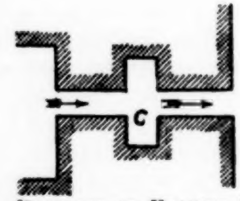


FIG. 7 DIAGRAM OF ELASTIC FLUID CONDUIT WITH INTERPOSED CHAMBER

MILLING-MACHINE VISE AS A SPECIAL MILLING FIXTURE, Hugo F. Pusep. A practical discussion for the purpose of showing how the milling-machine vise may be made serviceable in place of the more expensive special fixtures. The writer called attention to the fact that, under the present conditions, production may be held up for considerable periods, because of the difficulty of supplying the machine shop with the necessary special equipment. The article is of a strictly practical nature. (*American Machinist,* vol. 48, no. 26, June 27, 1918, pp. 1101-1103, 6 figs.)

Marine Engineering

AIR SUPPLY TO BOILER ROOMS, Richard W. Allen. The writer discusses the subject of air supply to boiler rooms where closed stokeholds are employed, a matter of particular impor-

tance where oil fuel is used, as this necessitates high air pressures being maintained in the boiler rooms.

The writer gives formulæ for determining the air pressure required to produce a certain speed, and points out that within the range of speeds and pressures actually employed on board ship, the speed varies as the square root of the pressure difference, or for an exit nozzle consisting of a short cylindrical pipe with ends not rounded off an air pressure of 1 in. water gage would produce approximately a speed of 54 ft. per sec. (assuming a coefficient of flow of 0.8).

As regards the velocity of air in the air shafts, the speeds recommended are from 20 to 25 ft. per sec. The pressure required to produce this velocity is relatively small, 0.13 in. to 0.20 in. water gage, but increases in the ratio of the square of the velocity.

Tests recently made on four different classes of ships indicate that the air trunks are sometimes constructed so that they necessitate very high speeds with resultant excessive power losses. It must be remembered that to obtain a speed of air a pressure difference has first to be set up. The pressure energy is converted into velocity energy, the greater part of which is lost so that very little of it is converted back to pressure. Hence, the higher the air speed the greater the loss.

Enlargements and Restrictions in the Air Passages.—Tests taken for steam have shown that when a chamber, such as *C* in Fig. 7, is interposed in a pipe run, even if it be of no

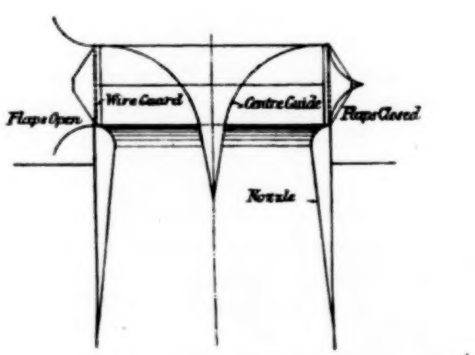


Fig. 8 New-type Cowl with Foul-Weather Flaps, with Center Guide and Nozzle

great length in the direction of the axis of the pipe run is sufficient to destroy completely the speed of the fluid approaching the chamber through the first portion of the pipe, and makes it necessary to have a further pressure drop expended in order to produce the speed afresh in the outgoing pipe.

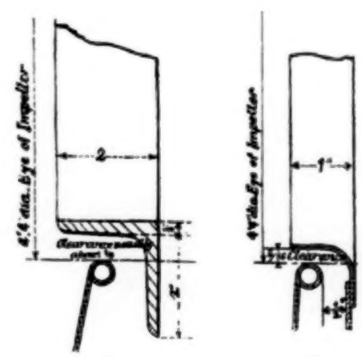
Such sudden enlargement often presents itself where the air shaft leading from the top deck down to the fan compartment emerges into the fan compartment. There are also many points in the air passage where restrictions in area are frequent and the writer enumerates the chief causes which produce such restrictions.

As regards intakes, the writer calls attention to experiments made to establish the relative efficiency of their different types. The essential requirement in designing a betetr intake was to produce a guide which would perform the protective duty, but at the same time induce the flow of air into the shaft, especially when partly closed against the water.

The results of these tests are shown in Fig. 5, where data are given of the tests with the old-type cowl shown in Fig. 6 and the new type with central guide and nozzle shown in Fig. 8.

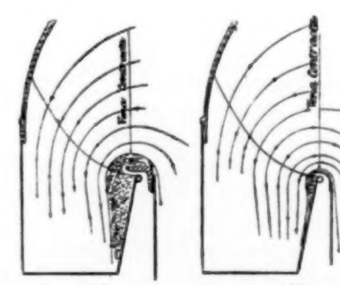
It is stated that the new design has an efficiency of 83 per cent against 35 per cent for the old design. In the new design the guides are of stream-line section and pivoted to the top of the air intake shaft so that they can be opened any desired amount. The other two recent innovations, namely, the center guide and nozzle, shown in Fig. 8, are embodied in the deck entry, the center guide in the form of a deflector or inverted pyramid attached beneath the cowl top, and the nozzle providing the *vena contracta* flow at the end of the entrance to the intake shaft.

In explanation of the manner in which the center guide and nozzle contribute to prevent loss of pressure, it has been proved that where these contrivances are not provided the whole of the space which they occupy is filled with eddy cur-



A B

Fig. 9 To the left—Fan Inlet Ring of Incorrect Design; to the right—Fan Inlet Ring of Improved Design



A B

Fig. 10 Air Streams through Rings in Fig. 9

rents, which are continuously absorbing energy. The reason for the formation of the eddies is partly that the direction of the air is changed on entering the shaft and owing to its velocity sweeps round the corners, and partly owing to the law of *vena contracta* for the flow of all fluids, either liquid or gaseous, at entrance or exit of duct. The center guide and nozzle conform to the correct line of fow to prevent the formation of any eddies. Another improvement to which importance is attached is fitting the diaphragms, places athwart-ships, subdividing the air intake shaft. When a ship is traveling at a high speed there is a tendency for the air to rush past the intake without being drawn in, and for the air which does enter to bank up in the after side of the intake shaft, with a consequent tendency to starve the forward fans. By fitting diaphragms, the tendency to unequal air supply fore and aft will be efficiently counteracted, and all the fans will receive their due share of air.

Inlet Rings. In many cases where the fan has failed to deliver its desired output, it has been found on examination to be due to inlet rings badly fitted to the fan eye, or to the inlet ring being of unsuitable shape. The inlet ring should be satisfactory as regards: (1) correct clearance, (2) angle of entry,

and (3) the avoidance of sharp corners. An inlet ring of recommended design with correct clearances is shown at B in Fig. 9, while an incorrectly designed ring with the sharp corner is shown at A of the same figure.

Fig. 10 shows how the design of the ring affects the shape of the air stream. At A, corresponding to ring shown at A, Fig. 9, the effective area of the fan eye is reduced, the velocity of entry increased, and consequently the momentum of the air in the direction parallel to the axis of the fan. Fig. 10 at B shows how the *vena contracta* is increased in area and the velocity of entry reduced. Further, with the lower momentum and elimination of the outer eddies, the radius of change of direction of the air becomes smaller.

Some interesting tests are reported on steam consumption of the fan installation, which show that the increase in the steam consumption is about 20 per cent due to 1 in. vacuum on the inlet. On the other hand, it was found that the performance of a fan may be considerably improved both in output and efficiency through correct design of the fan casing and of discharge of the air from the fan case. Thus, in comparative tests with the fan first in a concentric casing and next in a volute casing, it was found that the improvement due to the volute amounted to 30 per cent in output and 9 per cent in efficiency. Still better results were obtained in another test.

The subject of deflectors on fan casings and of direction of rotation of the fan is discussed in considerable detail on the basis of an interesting experimental investigation. (Paper read at the Spring Meeting of the Institution of Naval Architects, March 22, 1918, abstracted through *Engineering,* vol. 105, no. 2737, June 14, 1918, pp. 662-665, 18 figs, *epA*.)

Mechanics

CHARTS FOR THE DESIGN OF HELICAL SPRINGS, M. M. Brayton. The purpose of the article is to bring spring formulæ to the practical man in such a way that he may be able to use them without going through a lengthy calculation on the slide rule or by hand. For this purpose the writer offers several simple graphical solutions.

Helical springs are usually made from wire of circular cross-section and may be designed for either tension or compression. The formulæ apply equally well in either case. In the design of these springs several factors have to be considered, namely, diameter of wire, outside diameter or mean radius of coil, maximum safe axial load, number of coils per inch, maximum safe shearing stress of the steel and the deflection of the spring under a given load.

The following formula expresses the general relation:

$$W = \frac{\pi S d^3}{8(D-d)}$$

where W = total safe load on spring in pounds
d = diameter of wire in inches
D = outside diameter of coil in inches
S = maximum fiber stress in pounds per square inch, taken at 60,000.

The writer gives a chart enabling one to find W by merely drawing two lines perpendicular to each other.

Since it is sometimes convenient to have the same formula expressed in terms of the mean radius of the coil rather than the outside diameter, the writer gives another chart based on the formula

$$W = \frac{\pi S d^3}{16R}$$

where the same notation is used as above. Another chart is given to solve graphically the formula for the deflection of a spring under a given load.

The charts are not suitable for reproduction, but appear to be quite simple and convenient for use. (*American Machinist,* vol. 48, no. 24, June 13, 1918, pp. 1007-1011, 3 figs., *p*)

ON TWO-DIMENSIONAL FLUID MOTION, WITH FREE STREAM LINES, PAST AN OBSTACLE OF CURVED OUTLINE, J. G. Leathem (*Roy. Irish Acad.,* Proc. 34, pp. 11-39, March 1918). The author commences by giving in chronological order a list of papers to which he refers on the subject of two-dimensional flow of infinite liquid, with free stream lines, past a fixed obstacle of curvilinear outline. [For the author's previous paper on Two-Dimensional Fields of Flow, with Logarithmic Singularities and Free Boundaries, see Abs. 644 (1916).] In these researches there have been three distinct objectives: (1) A mathematical formulation, in terms of somewhat general functions, for any motion bounded partly by fixed and partly by free boundaries. (2) The exact or approximate adaptation of such a general formula to the case of an obstacle of arbitrarily assigned outline. (3) The choice of such forms of obstacle as shall correspond to liquid motions that can be precisely specified.

The exact adaptation of a general formulation to the case of an assigned obstacle seems bound to depend upon difficult functional equations, upon whose solution further progress must wait. The primary objective of a comprehensive formulation remains of fundamental importance, since such may well be the only possible point of departure for further progress in general theory, and the present paper offers a general formulation in terms of conformal curve factors—functions whose properties the author has discussed in previous papers. The method leads to expressions in terms of a definite integral involving a single arbitrary function of a real variable, and it is believed that in this form the properties of the relation between the fundamental variables are exhibited as simple as possible. From this formulation as starting point it has proved feasible to make a certain advance in knowledge, for there are obtained formulæ which specify the most forward points at which free stream lines can break away from an obstacle with smoothly curved sides. Attention is called to a probable connection between the positions of these points and the resistance which the obstacle offers to the stream when there are no free stream lines but the "wake" is in rotational motion; and a principle is deduced which may have important bearing on the problem of designing cylinders of small resistance—as, for example, struts for aeroplanes. The various sections of the paper respectively deal with: Notation and formulation; general formulæ; demonstration of generality; determination of points of departure of free stream lines from a curved obstacle; influence of the shape of the obstacle upon the divergence of the free stream lines, and the resistance to relative flow. The subject is treated mathematically throughout. (*Science Abstracts,* Section A—Physics, vol. 21, pt. 5 (no. 245), May 31, 1918)

Railroad Engineering

WELDING TRUCK SIDE FRAMES, BOLSTERS AND ARCH BARS. Report of a special committee made to the Master Car Builders' Association at its meeting in Chicago, June 1918.

The tests were made at the Bettendorf Company's plant, Bettendorf, Iowa, and at the plant of the American Steel Foundries Company at Alliance, Ohio. At Bettendorf a 1500-ton hydraulic press was used, and at Alliance a Riehlé testing

machine of 1,000,000 lb. capacity was used in making the tests.

The following data show the nature of the work performed. The frame shown in Fig. 11 had a crack $3\frac{3}{4}$ in. long, yet under tests did not show signs of opening until a load of 195,000 lb. was applied, and opened $\frac{1}{8}$ in. under a load of 230,000 lb. The frame used in Test No. 8, Book A, with a crack $1\frac{1}{2}$ in long, took a load of 332,000 lb. before the fracture occurred. Any methods employed in welding or preventing cracks of this character from extending would permit the frame to remain in service with safety, as it is only in isolated cases that frames ever failed without giving sufficient warning that by ordinary inspection replacement or repair could be made to prevent accident or derailment. In many cases they have been kept in service until the crack commenced to open or extend into the vertical section before removal and without anxiety on the part of mechanical officers responsible for their performance.

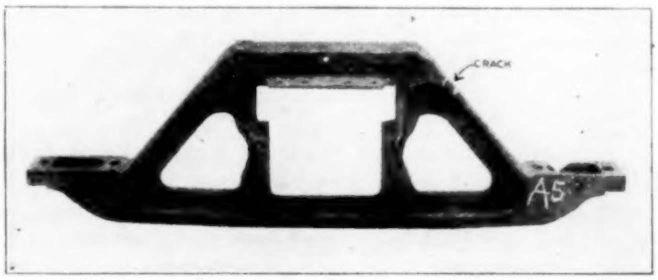


Fig. 11 Side Frame Before Welding

A number of the castings tested were welded where broken entirely across the tension member, yet the welds were sufficiently strong so that under test the casting broke at some location other than the weld. Therefore the proper welding of side frames and bolsters would be permitted, the limit to prohibit welding to be when the strength of the weld would not equal that of the joining sections.

The committee also made certain recommendations as to the manner of carrying out the welding operation. Among other things, it states that great care should be exercised to prevent welding under load, as internal strain is liable to be set up through welding, which can be avoided by preheating. It is good shop practice to preheat cast steel and pressed-form bolsters and side frames.

The following summary and conclusions were presented by the committee in connection with one series of tests:

Of the 23 tests as per data herewith, there were 10 castings in which the original fracture had consisted of a complete break of the entire tension member, the fracture extending well into the web, with the exception of test No. 19, the tension member of which was broken in from both sides, but not quite wholly fractured. (See photograph 1391.)

Of these 10 castings, the tension member of which was entirely fractured, only three broke in the weld under test. (See test No. 11, casting F-8; test No. 17, casting F-1; and test No. 20, casting F-3.)

If, in view of the data herewith submitted, it is desired to weld tension members that are almost wholly broken, with the fracture showing porosity, the welded portion should be built up to a considerable extent for 2 in. or 3 in. over the surface to compensate for what may have been a weak point.

As a conclusion, it may be said that the tests clearly indicate that properly made welds are satisfactory.

In view of these tests and experiments, it is considered important that in making such welds consideration should be given to the tensile strength of the welding material as compared with the tensile strength of the casting welded. If Norway iron or other welding metals of low tensile strength are used, the welds should be built up an amount sufficient to compensate for the total strength of section to be welded.

The Association by formal actions recognized as good practice and sanctioned the extension of autogenous welding to all parts of car equipment. (Abstracted through *Railway Age*, vol. 64, no. 25, June 21, 1918, pp. 1493-1496, 6 figs., *ep*)

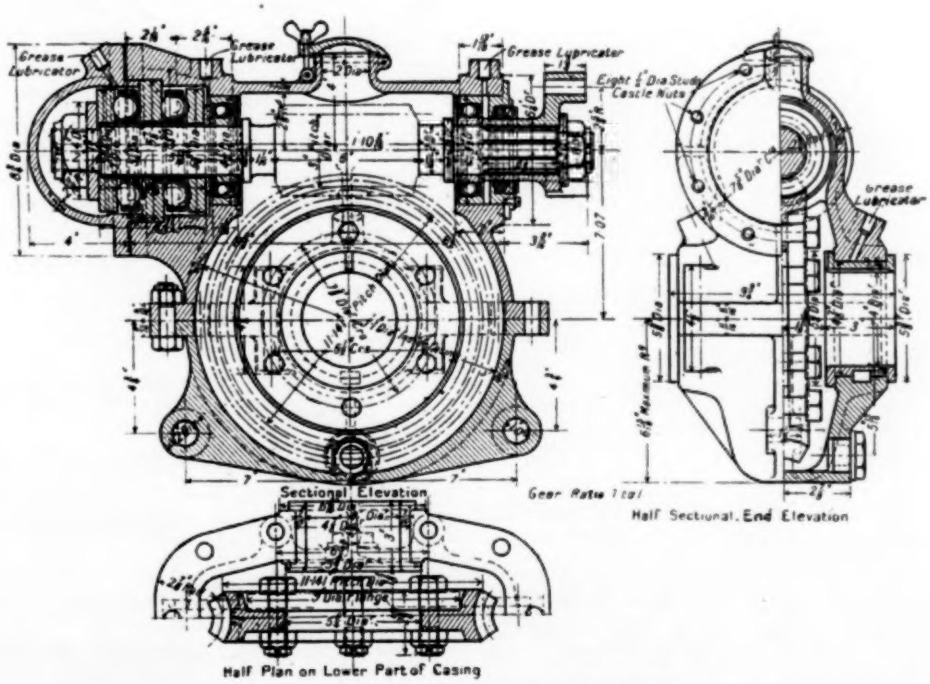


Fig. 12 Worm Drive of Bagnall Locomotive

Small Locomotives of Special Types. Description of the 40-hp. internal-combustion locomotive built by W. G. Bagnall, Ltd., Stafford, England.

The engine is of the four-cylinder type, with cylinders $4\frac{1}{8}$ by $5\frac{1}{2}$ in., and is started on gasoline and run on kerosene.

The arrangement of the worm and worm wheel is shown in Fig. 12. The thrust of the worm is taken up by ball bearings which are of the Hoffman type.

The cooling water, which is circulated on the thermosiphon system, is contained in a cylindrical tank arranged in precisely the same position as is the boiler in an ordinary steam locomotive. The tank, which is built up of two rings, 2 ft. $2\frac{5}{8}$ in. and 2 ft. 3 in. internal diameter and 5 ft. long, has internally dished ends which serve as tube plates. There are in all 56 $1\frac{1}{4}$-in. outside-diameter tubes, which are swelled to $1\frac{5}{16}$ in. diameter at the front ends. They are of steel and No. 16 W. G. The internal faces of the tube plates are 4 ft. 8 in. apart. The cooling effect is obtained by the passage of the air through the tubes, no mechanical arrangement for forcing the air through the latter being found necessary. The capacity of the water tank is 113 gal. The exhaust pipe from the engine is taken up the chimney, which serves as a silencer. A branch from the exhaust pipe is taken to a whistle which is operated

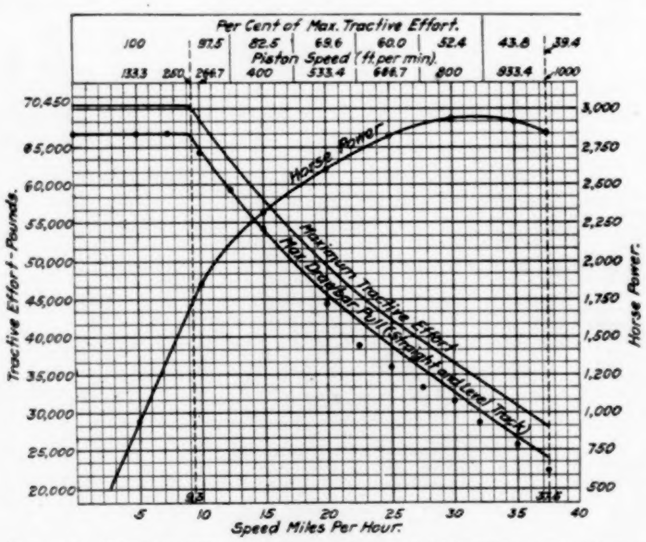


FIG. 13 TEST RESULTS SECURED WITH 2-10-2-TYPE LOCOMOTIVE ON THE UNION PACIFIC ON HEAVY GRADES

by cord from the cab. The arrangement of all the control levers in the cab follows closely steam-locomotive practice and appears to be excellent in every way.

In the same article is described a fireless locomotive built by a British concern. It is claimed to be the smallest fireless locomotive, from the point of view of weight, which has ever been constructed. In working order it weighs only $3\frac{1}{2}$ tons. The engine is carried on four wheels, but only one exhaust is driven. The outer casing is of canvas soaked in boiled oil and painted; the cab is of wood and the buffers are of special shape and material, the plungers being of lignum-vitæ backed up by Spencer springs. (*Engineering*, vol. 125, no. 3256, May 24, 1918, pp. 442-443, and 448, 7 figs., *d.*)

TESTS WITH 2-10-2 LOCOMOTIVE ON THE UNION PACIFIC. Data of tests made with one of 27 engines built last year by the Baldwin Locomotive Works. The new engines were designed to be used over a reconstructed section on the Union Pacific between Ogden, Utah, and Evanston, Wyo. They were designed primarily to move the same tonnage eastbound over the new line with a rolling grade of 1.14 per cent compensated for curvature that the Mikado locomotives handle over the lines with 0.83 per cent grades. It was also desired to eliminate helper service on this district which has several difficult grades.

In tests the 2-10-2-type locomotives handled 1800 tons eastbound over this division (some of the grades are still 63 ft. per mile, uncompensated for curvature) at an average running speed of 15 m.p.h. with the coal consumption of 358.4 lb. per thousand gross ton-miles.

The curves in Fig. 13 show the tractive effort and drawbar pull developed and the horsepower. A maximum of 2940 hp. was developed at a speed of 30 m.p.h., which is at the rate of 1 hp. for every 121.6 lb. weight of the locomotive in working order, an unusually good performance.

The article describes in some detail the construction of this type of locomotives, and gives the principal dimensions and ratios of the locomotives. (*Railway Age*, vol. 64, no. 26, June 28, 1918, pp. 1572-1574, 5 figs., *ed*)

Refrigeration

COLD ACCUMULATORS AND THEIR APPLICATION, Ernest S. H. Baars. The article discusses the purposes of temperature hold-over tanks used in the refrigerating industry and describes a new hold-over tank which uses a weak calcium chloride solution in frozen state. The physical phenomena involved are discussed.

The term "cold accumulator" sounds paradoxical, because technically speaking it is not possible to accumulate cold. What is actually meant is a surplus refrigerating capacity stored up for use later on. The apparatus may also be called a "hold-over tank," because it keeps the room cold during the short period while the refrigerating plant is shut down. Such hold-over tanks are used principally in connection with small refrigerating plants which are not operated continuously. They are also desirable for automatically controlled refrigerating plants to prevent excessively frequent starting and stopping of the compressor and wearing out of the control apparatus.

Hold-over tanks may be divided into three types. The first

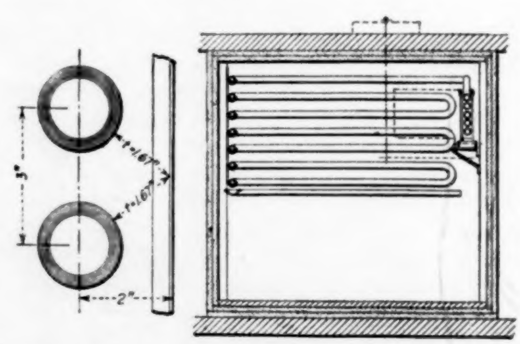


FIG. 14 HOLD-OVER TANK (TO THE LEFT, SPACING OF COILS; TO THE RIGHT, SECTION OF TANK)

is the brine tank. The second is a tank with the requisite amount of evaporating coils and a highly concentrated solution of chloride of calcium brine. While the machine is running the brine is cooled down to about 20 deg. fahr., and during the remainder of the way, when the machine is shut down, the heat that enters the room through the walls is absorbed by the cold brine in the tank, until the latter reaches a temperature when the refrigerating machine must be started again.

Several years ago the writer designed a third type, the working of which is based on a different principle. Instead of using a strong solution of calcium chloride, he uses a weak

solution and freezes it. For the successful operation of the hold-over tanks with frozen brine, tanks must have a special shape. Because of the fact that when a solution is frozen very slowly the water in it is frozen out and the salt crystals fall to the bottom of the vessel, it is essential that no brine be located too far from the evaporating pipe. By this means the salt crystals are kept in the ice and are ready to go in solution with the water as soon as the temperature rises.

Another feature is the flexibility of the walls of the tanks where corrugated sheets are used, thus preventing bursting through the expansion of the ice. Fig. 14 gives an idea of the construction of the tank.

The writer discusses in some detail the molecular movement of liquids as affecting the freezing point of solutions. (Paper read before the Engineers' Society of Milwaukee, abstracted through *Power*, vol. 48, no. 1, July 2, 1918, pp. 31-33, 2 figs. *d*)

Steam Engineering

EFFECT OF FEEDWATER TEMPERATURE AND RATE OF INJECTION UPON STEAM FLOW, Frank G. Philo. The writer shows that under any given condition the actual output of the boiler expressed in B.t.u. absorbed per unit of time is constant, regardless of the rate of feeding and the temperature at which boiler feedwater is injected. At the same time boiler output expressed in pounds of steam per unit of time varies widely with changing feedwater temperature and rate of feedwater injection.

The normal condition is considered to exist when the feedwater is fed into the boiler at the same rate at which the boiler is steaming, while any rate of feedwater injection above or below normal will increase or decrease the rate of boiler steaming and the amount of water in the boiler.

As regards feed temperature, it is stated that when it is the same as the temperature of the water in the boiler, feedwater injection does not affect the rate of steaming, but when the feedwater is higher in temperature than the water in the boiler an increase in steam flow occurs upon feeding water into the boiler.

The following formulæ and chart (Fig. 15) have been developed to show the magnitude of the above described effects.

H = total heat above feedwater temperature of 1 lb. of steam

L = latent heat of 1 lb. of steam under given conditions plus B.t.u. for superheating 1 lb. of steam (if superheated)

h = heat of feedwater from feed temperature to boiler temperature

R_s = rate of steaming

R_w = rate of feedwater injection

1 With feedwater shut off entirely, $R_s = \frac{H}{L} = 1 + \frac{h}{l}$

2 The rate of feedwater injection that would decrease steam flow to the rate of R_s would be $R_w = 1 + \frac{L - R_s L}{h}$

3 The rate of feedwater injection that would cause steam flow to cease would be $R_w = 1 + \frac{L}{h}$. (R_s = zero)

4 Under any given condition the sum of the heat absorbed by the feedwater and the heat used in boiling the water equals the total heat, or H absorbed by the boiler. As a formula this would be written $R_s L + R_w h = H$.

For examples of the foregoing take the conditions of 100 lb. gage, saturated steam, and 60 deg. fahr. feedwater temperature. Then $H = 1189 - (60 - 32) = 1161$ B.t.u.; $L = 880$ B.t.u.; and $h = 281$ B.t.u.

1 $R_s = \frac{H}{L} = \frac{1161}{880} = 1.32$, the rate of steaming with no feed.

2 Let $R_s = 50$ per cent, then $R_w = 1 + \frac{L - R_s L}{h} = 1 + \frac{880 - (0.5 \times 880)}{281} = 2.57$, the rate of feed required to reduce the rate of steam flow to 50 per cent of normal.

3 $R_w = 1 + \frac{L}{h} = 1 + \frac{880}{281} = 4.13$, the rate of feed required to stop steam flow.

Variable feedwater injection with the steady load is inimical to uniform steam pressure, but with loads that have a periodic fluctation, as in rolling mills, properly handled variable feedwater injection aids in the maintenance of the steam pressure.

The above discussion emphasizes the necessity of giving closer attention to the matter of correct boiler feeding. (*Power*, vol. 47, no. 26, June 25, 1918, pp. 915-916, 1 fig., *pt*)

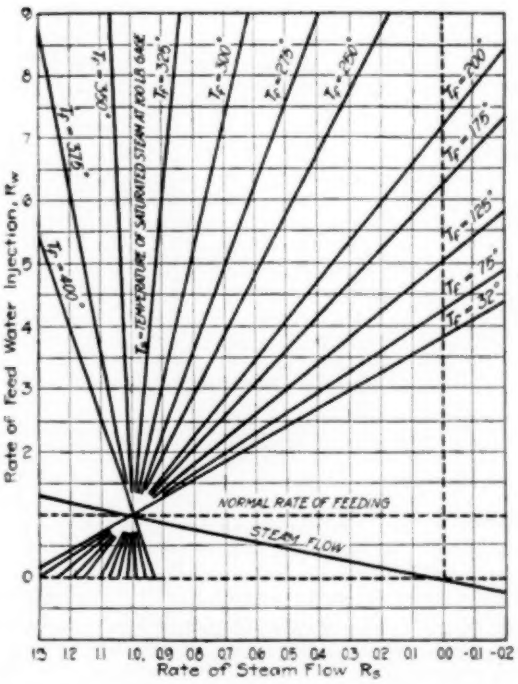


FIG. 15 EFFECT OF FEEDWATER INJECTION ON STEAM FLOW

BOILER-HOUSE OPERATION WITH REFERENCE TO VARIOUS FUELS, Knust (*Elek. Werk.* 6, 1916; *Elektrot. u. Maschinenbau*, 35, p. 47, Jan. 28, 1917, Abstract). It is economically preferable to distill hard coal rather than use it directly under boilers. All bituminous coals should be subjected to distillation. The author investigates the possibilities of substitutional fuels for boilers. For any given fuel there is direct dependance between the temperature of combustion, the quantity of air for combustion, the CO_2 content, and the temperature of the flue gases. The higher the CO_2 content and the lower the temperature of flue gases the more favorable the utilization of the fuel. The author gives formulæ for the initial temperature T, and by comparing this with the measured value, t, the loss of fuel may be determined at once. If $T = 2000$ deg. cent. and $t = 300$ deg. cent., the gross efficiency η of the firing is $(2000 - 300)/2000$, i.e., 85 per cent; for $T = 2000$ deg. and $t = 200$ deg., $\eta = 90$ per cent.

The author gives a table comparing gross efficiency, initial temperature, air surplus, and air and flue-gas quantities for a specified coal and various CO_2 contents. Formulæ are given for the air theoretically required for combustion and for the

volume of the flue gases developed. A daily consumption of 10,000 kg. of coal when the CO_2 content is 12 per cent and the flue-gas temperature 200 deg. cent. corresponds to 33,400 kg. per diem when the CO_2 content is 4 per cent and the flue-gas temperature 400 deg. cent; the great saving under the former conditions is obvious. A table is given showing for the principal fuels, the calorific value, evaporation factor, maximum CO_2 content, initial temperatures and overall efficiencies. Charts for four of the most important of these fuels show the efficiency as a function of the CO_2 content and the flue-gas temperature.

A mixture of one part of coke to two of hard coal yields no difficulties in working; and a mixture of one coke to three of brown-coal briquets is also satisfactory. Thoroughly good mixing is the principal requirement. If coke be used alone, the grate, air supply, and stoking arrangements must all be modified. Using brown-coal briquets instead of hard coal adds about 60 per cent to the grate and 14 per cent to the smoke-stack duty. A formula is given expressing the cash value of substitutional fuels in terms of heating value. (*Science Abstracts*, Section B—Electrical Engineering, vol. 21, pt. 5 (no. 245), May 31, 1918)

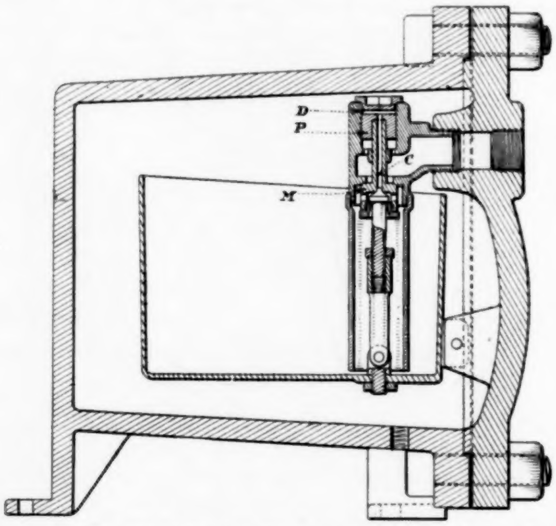


Fig. 16 Bucket-Type Steam Trap with Double Valve System

Steam Traps in Naval Service, F. G. Hechler. Description of the various classes of steam traps, with particular reference to their use in naval service.

As regards the capacity of steam traps, the author points out that while it is customary to designate steam traps according to the size of the inlet and outlet pipe connections, this method is not exact. Traps of the same nominal size often have widely different capacities. For instance, with the 1¼-in. traps tested at the Naval Engineering Experiment Station, the minimum capacity for any trap at 250 lb. steam pressure was found to be 2300 lb. of water per hour, while the maximum was 26,300 lb., or more than eleven times as much. This latter trap had a compound valve arrangement similar to that of Fig. 16. A capacity rating of a steam trap is of no value unless the pressure at which it was made is also given.

In order to secure satisfactory capacity results from steam traps it is desirable that they should be provided with interchangeable valves and valve seats adapted to various pressures. Also all valves should operate satisfactorily up to pressures somewhat higher than their rated value, which means that a 30-lb. valve should operate up to, say, 40 or 45 lb. for a margin of safety. This also makes it possible to grind in the valves when they become warm and even to rim out the seat. Both these operations are apt to enlarge the seating area of the valve, with the consequent danger of the trap becoming inoperative at the higher pressures.

The valve shown in Fig. 16, which gave such a large water discharge in the test above referred to, is representative of a type exclusively used in the naval service. With this type either a single- or compound-discharge valve may be used, and the latter gives the trap a very large capacity. This trap has the inlet and outlet connections in the cover so that it can readily be dismantled, provided the body is not fastened to the floor. The counterbored-recess type of gasket flange is used, and the best results will be obtained by carefully fitting the male and female ends so that there is only a small clearance.

The desirable features of a satisfactory steam trap for use in the naval service are summarized by the writer as follows:

Strong, rugged construction with properly designed gasket joints which may be kept tight without difficulty.

Inlet and outlet connections in the body of the trap.

The outlet valve located above the bottom of the trap where it is not likely to become clogged.

An accessible inlet strainer.

Powerful valve-operating mechanism so that the outlet valve may be large enough to give the trap ample capacity.

Proper functioning when oscillated.

A gage glass or other device for easily determining whether the trap is operating properly. For this purpose a hand gear for opening the outlet valve is also often convenient.

To secure the best results with traps they should be installed on the ship with the axis fore and aft to minimize the effects of a heavy sea. They should always be connected to the lines with unions, and every trap should be bypassed. (*Journal of the American Society of Naval Engineers*, vol. 30, no. 2, May 1918, pp. 239-254, 8 figs., *dcp*)

Thermodynamics

Dependence of the Thomson-Joule Effect for Air on Pressure and Temperature for Pressures Up to 150 Atmospheres and Temperatures from — 55 Deg. to + 250 Deg. Cent., F. Noell (*Zeits. Vereines Deutsch. Ing.*, 62, pp. 49-54, Feb. 2, and pp. 63-67, Feb. 9, 1918). The temperature change which a gas experiences by expansion without doing external work, i. e., the Thomson and Joule effect, is a phenomenon first observed by Thomson and Joule but only for moderate pressures and a small temperate range. A systematic investigation has been commenced by E. Vogel at the Munich Polytechnic Institute and participated in by the authors, employing much wider limits. All previous work on the subject had been so arranged that passage from a given high pressure to that of the atmosphere was made by a reducing valve whose low-pressure side communicated with the atmosphere. In this way it was not possible to measure the cooling effect at various pressures, and so study its dependence upon pressure and temperature. The innovations to the method now described in the paper provided for the adjustment of pressure differences on both sides of the reducing valve. The apparatus is discussed at great length and diagrammatically illustrated; the temperature measurements were made by means of a platinum resistance thermometer. Following this comes a full description of the experimental procedure accompanied by nine tables of results, the data being obtained at — 34 deg., — 55.4 deg., — 0.6 deg., 49.2 deg., 99.3 deg., 149.7 deg., 199.3 deg. and 249.9 deg. cent., respectively. The interpretation of the results oc-

cupies the second communication to which seven curves are attached.

The experiments have firmly established the dependence upon pressure and temperature of the Thomson-Joule effect for air between the above temperature limits. The general result may be expressed by the formula:

$$\triangle = dT/dp = \frac{A_1 - A_2 p}{T} + \frac{B_1 - B_2 p}{T^2} + \frac{C_1 - C_2 p}{T^4} + D_1 - D_2 p$$

where $\triangle$ is the cooling for 1 atmospheric pressure change, T the absolute temperature of the gas at the high-pressure side, p the arithmetic mean of the pressures on the high and low sides, dp the pressure difference, dT the corresponding temperature difference, and A_1, A_2, B_1, B_2, C_1, C_2, D_1, D_2 constants. At all temperatures investigated a linear decline of the cooling effect by the above formula the temperature drop caused by the reducing valve can be calculated for higher initial pressures by integration and has been depicted graphically, whereby it is seen that the proportionality of the cooling with the pressure difference at low temperatures and high pressures is no longer so exact. The results of this investigation agree with those of others. By extrapolation, a portion of the inverse curve has been determined. From the observed cooling effect the specific heat of air, C_p, was calculated for the region of the experiments with confirmation of the values obtained by Scheel and Heuse and by Swann for one atmosphere. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 5 (no. 245), May 31, 1918)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

Rehearsal of Demobilizing Plan in Britain

Plans for the demobilization of the British fighting forces and the furnishing of civil employment for the men as soon as possible after the war are being worked out by the Government. The system as explained in an official statement is essentially as follows:

First, the men will be provided with substantial refreshment. A brief "fall in" will be called and there is to be a handing in of equipment. All must be given up except the uniform which the soldier is wearing and his greatcoat, the latter to be returned after a month of furlough, to which each man is entitled. A man will be allowed to keep his soldier clothes, with the exception of the greatcoat.

At the receiving huts of the dispersal depot the soldier will be expected to "hand over" all his accouterments. In another department each soldier is given an advance, and at the same time he gets a document, made out to the principal post office of the district to which he is going, enabling him to receive in three equal installments, during the period of his 28 days' furlough, the remainder of the money owing to him either on deferred pay, service gratuities or from any other sources.

On his application the man is presented with an out-of-work insurance policy, which is valid for a year. It is in the form of a document which entitles the holder to receive a fixed sum for a definite period, when unemployed, from a post office. The rate and the period will be fixed "when the time comes."

Finally, the men are grouped into different huts, each of which is occupied by those who are destined for a certain locality, and when the locomotive drags the empty carriages into the railway station, the Tommies enter them and are rapidly carried away to their friends and relations. This is the never-ending procession which will go on morning, noon and night, month after month, when the happy era of peace arrives.

It may be surmised with every degree of certainty, that all men on getting to the dispersal station may not be quite as fit as would warrant them being sent on post haste. That has also been provided for. Medical men will be there, and those who are not quite up to the mark will be detained in the hospital ward until able to travel.

At a camp not far from London there has been a rehearsal of the methods to be adopted to "disperse" the men. Big as was the job to get men into the army, it will be a bigger job to get them out of it, but the country may be sure that everything that can be done will be done to enable the soldiers to reach their homes and get employment with the minimum of friction.

The scheme is far-reaching in its ramifications. It has been carefully thought out by the British authorities, who have not only had to consider the position at home but also how it will fit in with the convenience of our French and Italian allies, with the Dominions overseas, with transport facilities from Salonika, Mesopotamia, and Palestine and from other parts of the world. Ships and railways will obviously play an important part in this huge undertaking; and so far as France is concerned the wharf space at the quays across the Channel will be a desideratum of first importance. It is expected, in fact, to dominate the situation. How long it will take to demobilize our army of millions is a question to which even those occupied in the task are not prepared to give a definite reply.

Eighteen dispersal depots are to be established in England, Scotland and Wales. They will be chiefly in populous districts, from which the majority of the fighting men have been drawn.

When the armies have been got away, the distribution of the soldiers into civil employment is a feature of the demobilization which rests with the Ministry of Labor. Up to the point of dispersal the army authorities will have acted in conjunction with the Labor Ministry and the trade unions. Then to some extent they part company. The basis of the whole scheme is industrial reconstruction and not military convenience. The problem of the Ministry of Labor is to tell us who the men are who are required first, and we have devised a scheme by which any man having his job ready for him will be released early. Those who have no occupations to go to will naturally remain in the army a little longer than those who have. Many may desire to remain with the colors, and with those it may be necessary to garrison India and to take the place of men there who will be anxious to get home.

On the other hand, men in trade and industry will be released with the utmost speed, as well as men needed in the factories and in other occupations which it is urgent shall get into their stride as early as possible.

The work involved in keeping records of what is likely to be the after-the-war conditions of millions has been prodigious. This has been mainly the business of the Ministry of Labor. Communication has been kept with employers, and happily, with few exceptions, there is a fine spirit in existence among them to welcome back the men who have left home to face the dangers of the battlefields and the sea.

No doubt when the demobilization comes about there will be many rough edges in the scheme which will need making smooth, but that can only be done as the result of actual experience. The rehearsals have been very successful and, in the opinion of those best able to judge, give promise of an equally successful realization when the moment of disbandment has been reached. (*Journal of Commerce*, July 1, 1918, p. 2)

Under the title, The Deepest Well in the World and the Next Deepest in America, Dr. Israel C. White, state geologist of West Virginia (Morgantown, W. Va.) has described (1) a well 7386 ft. deep put down by the Hope Natural Gas Co., eight miles from Clarksburg, W. Va., and (2) a well 7248 ft. deep owned by the People's Natural Gas Co., and situated five miles from McDonald, Pa. The paper, which has been printed as an illustrated pamphlet of 22 pages, was presented by Dr. White before the National Gas Association of America last May. The second of the two wells described is said to be the third deepest well in the world. (*Engineering News-Record*, July 18, 1918.)

SELECTED TITLES OF ENGINEERING ARTICLES

AERONAUTICS

AIRPLANE PERFORMANCE DETERMINED BY ENGINE PERFORMANCE, G. B. Upton. The Sibley Journal of Engineering, vol. 32, no. 9, June 1918, pp. 137-142, 3 figs., 3 tables.

AERONAUTICAL PROBLEMS ELUCIDATED BY LESSONS FROM PARADOXICAL WINDWHEELS, Thomas O. Perry. The Michigan Technic, vol. 31, no. 2, May 1918, pp. 80-91, 9 figs.

IL PROBLEMA DEGLI IDROVOLANTI, A. Guidoni. Rivista Marittima, Anno 51, no. 3, March 1918, pp. 191-196, 9 figs. Brief discussion of hydroaeroplane design.

LATERAL STABILITY OF AN AIRPLANE, Frederick Bedell. The Sibley Journal of Engineering, vol. 32, no. 10, July 1918, pp. 154-156, 11 figs.

THE NEW GIANT GERMAN AEROPLANE. The Engineer, vol. 125, no. 3259, June 14, 1918, p. 512.

WAR AIRPLANES OF TODAY, F. L. Faurote. Automotive Industries, vol. 39, no. 1, July 4, 1918, pp. 14-17, 12 figs. Descriptive paper presented before the summer meeting of the Society of Automotive Engineers in June 1918, at Dayton, Ohio.

THE ENLISH S. E. V. A. SINGLE-SEATER FIGHTER. Aerial Age Weekly, vol. 7, no. 17, July 1918, pp. 822-825, 7 figs.

AIR MACHINERY

*TEST ON ROTARY BLOWERS AND EXHAUSTERS. The Blast Furnace and Steel Plant, vol. 6, no. 7, July 1918, pp. 298-299, 3 figs.

BLAST FURNACES

PRINCIPAL CHANGES IN BLAST FURNACE LINES, J. G. West, Jr. The Blast Furnace and Steel Plant, vol. 6, no. 7, July 1918, pp. 289-296, 26 figs.

BUILDING CONSTRUCTION

COST OF CONSTRUCTING AND MOVING PORTABLE CAMP BUILDINGS. Engineering & Contracting, vol. 49, no. 25, June 19, 1918, p. 614, 3 figs. Figures for special type of portable buildings, 18x54-ft. sleeping quarters, 18x54-ft. kitchen and dining room, 18x18-ft. commissary and 18x18-ft. office, designed by U. S. Office of Public Roads and Rural Engineering for housing 40 men.

HOW A CHAIN FACTORY WAS BUILT AND THEN OCCUPIED, Charles Lundberg. Iron Age, vol. 101, no. 25, June 20, 1918, pp. 1585-1590, 15 figs. Description of plant of Diamond Chain and Mfg. Co., Indianapolis.

CHAINS

*TESTS OF CAST STEEL ANCHOR CHAINS. The Marine Review, vol. 48, no. 7, July 1918, pp. 294-297, 15 figs., 3 tables.

*HOW CAST STEEL CHAINS ARE MADE, Chester K. Brooks. The Iron Trade Review, vol. 63, no. 1, July 4, 1918, pp. 29-32, 19 figs.

*ELECTRIC CAST-STEEL ANCHOR CHAIN, H. Jasper Cox. The Iron Age, vol. 102, no. 1, July 4, 1918, pp. 25-26.

*SOME EXPERIMENTS WITH CAST STEEL CHAIN, Chester K. Brooks. The Iron Age, vol. 102, no. 1, July 4, 1918, pp. 26-28, 3 figs., 1 table.

CONVENTIONS

CERAMIC CONFERENCE HELD IN PITTSBURGH. The Clay Worker, vol. 69, no. 6, June 1918, pp. 759 and 790.

IRON AND STEEL INSTITUTE, ANNUAL MEETING, MAY 2-3, 1918:
- Defects in Steel Ingots, J. N. Kilby.
- Non-Metallic Inclusions: Their Constitution and Occurrence in Steel, Andrew McCance.
- A Cause of Failure in Boiler Plates, Walter Rosenhain.
- Effect of Mass on Heat Treatment, E. F. Law.
- The Effect of Cold-Work on the Divorce of Pearlite, J. H. Whiteley.
- Effects of Cold-Working on the Elastic Properties of Steel, J. A. Van Den Broek.
- Iron, Carbon and Phosphorus, Dr. J. E. Stead.
- Presidential Address, Eugene Schneider.
- Committee No. 2—For Blast-Furnace Practice.
- Determination of Cobalt and Nickel in Cobalt Steel, W. R. Schoeffler and A. R. Powell.
- Damascene Steel, Col. N. Delaiew.
- Note on Inclusions in Steel and Ferrite Lines, Dr. J. E. Stead.
- Technical Aspects of Establishment of Heavy Steel Industry in India, with Results of Some Researches Connected Therewith, A. McWilliam.
- Blast-Furnace Bears, Dr. J. E. Stead.
- Copper Tuyeres for Blast-Furnaces, A. K. Reese.
- Fuel Economy in Blast-Furnaces, T. C. Hutchinson.
- Jurassic Ironstones of the United Kingdom Economically Considered, F. H. Hatch.
- Importance of Coke Hardness, G. D. Cockrane.

YEARLY MEETING OF THE AMERICAN CONCRETE INSTITUTE. Railway Age, vol. 65, no. 1, July 5, 1918, pp. 17-21, 4 figs.

ELECTRICAL APPLICATIONS

PROTECTING THE PANAMA LOCK VALVES AGAINST ELECTROLYSIS, R. H. Whitehead. Engineering News-Record, vol. 80, no. 26, June 27, 1918, pp. 1219-1221. Describes protective covering applied and wood separators.

ELECTRIC FURNACE FOR FORGING STEEL, Wirt S. Scott. Iron Age, vol. 101, no. 26, June 27, 1918, pp. 1676-1677. Experimental electric forging furnaces of the resistor type leading up to commercially successful units. Silicon carbide as a resistor. From a paper read before the Association of Iron and Steel Electrical Engineers.

POWER-STATION EARTH CONNECTIONS, P. H. Adams, Power, vol. 48, no. 2, July 4, 1918, pp. 40-42, 8 figs. Discussion of proper method of putting down earth connections for electrical equipment and the effect of corrosion in power-plant equipment when the proper attention is not given to maintaining the earth connection at a low resistance.

ENGINEERING MATERIALS

EFFECT OF PHOSPHORUS ON SOFT STEELS, J. S. Unger. Iron Age, vol. 101, no. 24, June 13, 1918, pp. 1538-1540, 3 figs. Results of experiments showing that in soft steels an increase in phosphorus of 0.01 per cent is equivalent to an increase in tensile strength of about 850 lb. per sq. in. From a paper read before the American Iron and Steel Institute, May 1918.

*STEELS FOR GEARS AND THEIR TREATMENT, Geo. A. Richardson. The Iron Age, vol. 101, no. 26, June 27, 1918, pp. 1668-1670, 2 figs.

CONCESSIONS MADE IN STEEL STANDARDS. The Iron Trade Review, vol. 63, no. 1, July 4, 1918, pp. 33-35.

A SUMMARY OF IRON AND STEEL PROCESSES. The Blast Furnace and Steel Plant, vol. 6, no. 7, July 1918, pp. 296-297.

PERMISSIBLE STRESSES IN STEEL, Ewart S. Andrews. The Engineering Review, vol. 31, no. 7, January 15, 1918, pp. 199-201, 4 figs.

MALLEABLE CAST IRON, Prof. T. Turner. The Journal of the West of Scotland Iron and Steel Institute, vol. 25, no. 6, March 1918, pp. 285-302, 17 figs.

FOUNDRY

WESTINGHOUSE PLANT AT SOUTH BETHLEHEM. The Iron Age, vol. 102, no. 1, July 4, 1918, pp. 22-24, 5 figs. A description of the interesting features of equipment of foundry and forging machine and erection shops.

FUELS AND FIRING

PITCH AS A FUEL FOR POWER GENERATION, John B. C. Kershaw. Power, vol. 47, no. 26, June 25, 1918, pp. 904-906. A summary of the most recent patents and experiments relating to the use of coal-tar pitch as a fuel for steam boilers and for internal-combustion engines.

ECONOMIC HANDLING OF ASHES, Reginald Trautschold. Industrial Management, vol. 56, no. 1, July 1918, pp. 17-20.

REPORT OF COMMITTEE ON FUEL ECONOMY AND SMOKE PREVENTION. Railway Age, vol. 64, no. 25, June 21, 1918, pp. 1516-1519. 1 fig.

* Abstracted in the Engineering Survey in this issue.

FURNACES

BY-PRODUCT COKE OVEN PRESSURE REGULATION, Charles H. Smoot. The Blast Furnace and Steel Plant, vol. 6, no. 7, July 1918, pp. 306-310, 2 figs. First of a series of articles dealing with the subject by by-product coke-oven pressure regulation. The general theory of regulation is discussed.

HOISTING MACHINERY

A LARGE ELECTRIC CRANE, H. Y. Stukey. American Machinist, vol. 49, no. 2, July 11, pp. 71-72, 3 figs. Description of an electric traveling crane with total lifting capacity of 431 net tons.

FEDERAL SHIPS ERECTED BY DERRICK TRAVELERS BUILT FOR LONG SERVICE. Engineering News-Record, vol. 80, no. 24, June 13, 1918, pp. 1129-1132, 6 figs. Problem studied on basis of bridge-erection experience; derricks of pillar-crane type; low stresses and special bearings for reliability; gantry truck details from shop-traveler practice.

OPERATION AND MAINTENANCE OF ELEVATORS—GEARED TRACTION MACHINES, R. H. Whitehead. Power, vol. 47, no. 26, June 25, 1918, pp. 900-903, 8 figs. Construction and operation of three geared types of traction-elevator machines discussed.

INTERNAL-COMBUSTION ENGINEERING

TWO ESSENTIAL CONDITIONS FOR BURNING TAR-OIL IN DIESEL ENGINES, P. H. Smith. Page's Engineering Weekly, vol. 32, no. 716, May 31, 1918, pp. 256-257. Paper read before the Diesel Users' Association (British). The conditions of which the writer speaks are atomization and turbulence. The sleeve pulverizer system is discussed in particular.

SOME NOTES ON THE OPERATION OF GAS AND OIL ENGINES, PART 2, WATER COOLING, Jas. G. Walthew. Gas and Oil Power, vol. 13, no. 153, June 6, 1918, pp. 125-126, 2 figs, 1 chart.

DETAILS OF HIGH-SPEED INTERNAL COMBUSTION ENGINES, Harry R. Ricardo. Engineering, vol. 105, no. 2735, May 31, 1918, pp. 620-623, figs. 8-28. Continuation of paper read on April 30 before the Northeast Coast Institution of Engineers and Shipbuilders at Newcastle-upon-Tyne. Subjects discussed in this issue: volumetric efficiency of engine; design of pistons; a comparison of wear and tear on slow and high-speed engines. Profusely illustrated with drawings and curves.

*EFFECT OF CIRCULATING WATER TEMPERATURES ON THE LUBRICATING OIL USED IN INTERNAL-COMBUSTION ENGINES. Lubrication, vol. 5, no. 8, June 1918, pp. 11-14, 1 fig.

TWO-STROKE ENGINES, George Funck. The Automobile Engineer, vol. 8, no. 115, June 1918, pp. 154-158, figs. 8-13. Second installment serial on theory and design of two-stroke-cycle engines.

THE POSSIBILITIES OF THE HVID ENGINE, E. B. Blakely. Gas Engine, vol. 20, no. 7, July 1918, pp. 341-347, 9 figs. Description of the four-cycle Hvid-type motor using kerosene and heavier oils with ignition by heat of compression, with results of tests made on a 5¾ x 9-in. engine. Paper read before the National Gas Engine Association, June 1918.

CONSERVATION OF MOTOR FUEL AS AFFECTED BY LUBRICATING OIL, S. F. Lentz. Gas Engine, vol. 20, no. 7, July 1918, pp. 327-333. Results of experiments showing change of physical state of oil during use in motors. Abstract of paper read before the National Gas Engine Association, June 1918.

THE SEMI-DIESEL OIL ENGINE, L. H. Morrison. Power, vol. 48, no. 2, July 9, 1918, pp. 47-49, 7 figs. Points out a difference between semi-Diesel and low-compression oil engines and discusses some types of the former.

LABOR

TRAINING SHIPYARD WORKERS BY EMERGENCY FLEET CORPORATION METHODS, R. V. Rickford. International Marine Engineering, vol. 23, no. 6, June 1918, pp. 325-328, 4 figs.

PIECE WORK SYSTEM IN RAILWAY SHOPS, W. J. McClennan. Railway Mechanical Engineer, vol. 92, no. 7, July 1918, pp. 411-416, 5 figs. A discussion of the organization of the methods for determining proper prices, and of the forms used.

THE LABOR PROBLEM OF A GREAT FRENCH SHELL FACTORY, Robert K. Tomlin, Jr. American Machinist, vol. 49, no. 1, July 4, 1918, pp. 22-24, 8 figs.

A SYSTEM OF LABOR COMPENSATION, M. K. Smogorjevsky. Railway Mechanical Engineer, vol. 92, no. 6, June 1918, pp. 325-329, 2 figs. A combination of the Taylor, piece-work and Prusso-Hessian methods developed in a Russian railway shop.

LOT COST SYSTEM IN MAKING WINCHESTER GUNS, W. E. Freeland. Iron Age, vol. 102, no. 1, July 4, 1918, pp. 8-10, 4 figs. Bonus payments to machine adjusters and instructors a feature of the production system; some of the cost forms used.

AMERICANIZATION A PROBLEM IN HUMAN ENGINEERING, Henry D. Hammond. Engineering News-Record, vol. 80, no. 24, June 13, 1918, pp. 1116-1119.

THE FUTURE OF THE APPRENTICE, C. C. Hermann. Machinery, vol. 24, no. 10, June 1918, p. 889. Results of present training methods and suggestions for an improved course.

LUBRICATION

THE LUBRICATION OF MACHINE SHOP EQUIPMENT. Lubrication, vol. 5, no. 8, June 1918, pp. 2-5. A general discussion of the subject presented by the Lubricating Engineering Association with the main purpose of showing how proper lubrication may help to eliminate noise and to prolong the life of machines and tools.

WASTE OIL TROUBLES, W. A. Taller. National Engineer, vol. 22, no. 7, July 1918, pp. 296-298, 1 fig.

MARINE ENGINEERING

WELDING SHIP'S PARTS TOGETHER, James G. Dudley. International Marine Engineering, vol. 23, no. 6, pp. 359-360, 4 figs. An account of the development of the electric welding of ships by the Emergency Fleet Corporation.

FERRO-CONCRETE SHIPS, T. J. Gueritte. International Marine Engineering, vol. 23, no. 6, pp. 329-334. Discussion of materials and systems of construction; plastered and molded ships; weight, cost and durability. Paper read before the North-East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne, March 1918.

GOVERNMENT DESIGNS AND BUILDS 3500-TON CONCRETE SHIPS. Engineering News-Record, vol. 81, no. 1, July 4, 1918, pp. 17-21, 7 figs. Shape and size of vessels under construction follow standard wooden ships of same tonnage. Usual concrete details adapted to sea-going ships.

DESIGN STEEL SHIPS FOR MAXIMUM EFFICIENCY OF BRIDGE-SHOP FABRICATION. Engineering News-Record, vol. 81, no. 1, July 4, 1918, pp. 5-12, 13 figs. Description of the fabricated-ship construction at the Hog Island plant and some of the features of construction.

MACHINE PARTS

INGENIOUS MECHANICAL MOVEMENTS, Franklin D. Jones. Machinery, vol. 24, no. 10, June 1918, pp. 902-908, 10 figs. Second of a series of articles on mechanism.

BEARINGS FOR MACHINE SHOP EQUIPMENT, Edward K. Hammond. Machinery, vol. 24, no. 11, July 1918, pp. 975-987, 21 figs. First of a series of articles. Deals with various forms of plain bearings which have demonstrated their ability to give satisfaction in service.

MACHINE SHOP

*DROP FORGING PROBLEMS DISCUSSED. The Iron Age, vol. 101, no. 26, June 27, 1918, pp. 1650-1654.

GRINDING AND LAPPING THREADS, J. E. Lindgren. Machinery, vol. 24, no. 11, July 1918, pp. 1023-1024, 5 figs. Attachments, fixtures and laps used for producing accurate threads.

MANUFACTURING WRIGHT ROLLER BEARINGS. Machinery, vol. 24, no. 11, July 1918, pp. 1019-1021, 9 figs. Description of the processes involved in machining parts, heat-treating, assembling and inspecting.

OPERATING THE GRIDLEY AUTOMATIC TURRET LATHE—1, Douglas T. Hamilton. Machinery, vol. 24, no. 10, June 1918, pp. 926-931, 16 figs. Complete instructions for tooling, setting up, and operating. 2, July 1918, pp. 1016-1018, 4 figs. Examples of camming and setting tools.

Manufacturing Operations on Jewelry Settings, J. V. Hunter. American Machinist, vol. 49, no. 2, July 11, 1918, pp. 47-52, 16 figs.

Manufacturing the Curtiss Airplane Cylinder, II. The Water Jacket, G. A. Ranger. American Machinist, vol. 49, no. 2, July 11, 1918, pp. 62-65, 15 figs. Describes preparation of the Monel metal jacket and the brazing operations.

Work in a Texas Repair Shop, Frank A. Stanley. American Machinist, vol. 49, no. 2, July 11, 1918, pp. 53-56, 13 figs. Description of a varied line of work in the blacksmith shop and structural department of a large smelter; bending, forming and welding operations; some special tools.

Design and Construction of Work-Benches, Frank H. Mayoh. Machinery, vol. 24, no. 10, June 1918, pp. 880-886, 24 figs. Bench legs and tops; location of benches; portable work benches.

Metallic Electrode Arc Welds, O. S. Eschholz. Railway Mechanical Engineer, vol. 92, no. 7, July 1918, pp. 416-419, 7 figs. Suggestions for determining the quality of the joint; proper methods which will secure good results.

Fusion Welding Fallacies—1, S. W. Miller. Machinery, vol. 24, no. 11, July 1918, pp. 1014-1015, 5 figs. Some common beliefs and why they are unsound.

Arc Welding of Mild Steel, O. H. Eschholz. The Electric Journal, vol. 15, no. 7, July 1918, pp. 247-250, 13 figs.

*Effect of Mass on Heat Treatment, E. F. Law. Engineering, vol. 105, no. 2736, June 7, 1918, pp. 647-650, 17 figs.

Bluing Steel, W. B. Greenleaf. Machinery, vol. 24, no. 11, July 1918, pp. 997-998, 2 figs. Materials, arrangements and methods used on light sheet-steel work.

Heat Treatment of Axles, Dwight D. Miller. Railway Mechanical Engineer, vol. 92, no. 7, July 1918, pp. 419-421, 3 figs. The scientific heat treatment of locomotive and car axles made possible by use of electric furnace.

MACHINE TOOLS

A New Nut Making Machine. The Engineer, vol. 125, no. 3259, June 14, 1918, pp. 510-511, 3 figs.

*Designs High-Cutting Speed Planer. The Iron Trade Review, vol. 63, no. 1, July 4, 1918, pp. 22-23, 1 fig.

Intensive Production on Drilling Machines—1, Edward K. Hamilton. Machinery, vol. 24, no. 10, June 1918, pp. 914-921, 5 figs. Organization of the drilling department and use of special equipment on machine to adapt them for a wide range of work.
2, July 1918, pp. 1030-1034, 12 figs. Design of cutting tools and work-holding fixtures for handling turned lathe work on drilling machines.

The Inspection of Machine Tools, Ethan Viall. American Machinist, vol. 49, no. 1, July 4, 1918, pp. 13-17, 15 figs. Description of testing methods used in some well-known machine-tool-building shops.

War-Time Repairs in the Navy—III, General Repair Work, Frank Stanley. American Machinist, vol. 48, no. 26, June 27, 1918, pp. 1091-1094, 10 figs. The making of small and medium-sized parts. Overhauling machine tools for ships.

Results of Faulty Tool Designing, F. B. Jacobs. Machinery, vol. 24, no. 11, July 1918, pp. 1028-1029, 9 figs. Examples of tools and fixtures that did not work, with reasons for failures.

The Wilt Process of Twist Drill Manufacture, Franklin D. Jones. Machinery, vol. 24, no. 11, July 1918, pp. 1007-1013, 11 figs. A process in which all machining operations on twist drills, except grinding, are done automatically.

Supports for Milling Machine Arbors, Luther D. Burlingame. Machinery, vol. 24, no. 11, July 1918, pp. 992-996, 18 figs. Historical review showing early designs with the development of types now used.

MEASURING APPARATUS AND METHODS

Example of Precision Gage Making. Machinery, vol. 24, no. 10, June 1918, pp. 878-879, 5 figs. Methods of making and testing a gage requiring unusual accuracy.

Universal Milling Machine Dynamometer, R. Poliakoff. Machinery, vol. 24, no. 10. June 1918, p. 932, 4 figs. Describes a dynamometer designed for measuring the pressure that a milling-machine cutter exerts on the work and on the various parts of the milling machine through the work.

Indicator Gages Used in Gasoline-Engine Construction, C. C. Marsh. Machinery, vol. 24, no. 10, June 1918, pp. 910-913, 5 figs. Gages for inspecting cylinder depth, length, external diameter, cam lift, profile and eccentricity.

Contour- and Radius-Measuring Instrument. Machinery, vol. 24, no. 10, June 1918, pp. 898-899, 5 figs. Universal type of instrument for measuring irregular profiles, radius gages and contours that cannot be tested by ordinary measuring devices.

Distantiagraph, W. D. Farris. Proceedings of the U. S. Naval Institute, vol. 44, no. 181, March 1918, pp. 557-559, 3 figs. Describes an instrument designed to determine the actual distance a ship must pass over a light or point.

Gages and Thermometers, John E. Starr. Refrigerating World, vol. 53, no. 6, June 1918, pp. 11-12.

Viscosity Determinations in Absolute Units. Engineering, vol. 105, no. 2737, June 14, 1918, pp. 655.

MECHANICS

Non-Molecular Structure of Solids, Arthur H. Compton. Journal of The Franklin Institute, vol. 185, no. 6, June 1918, pp. 745-774, 15 figs.

Approximate Live-Load Stresses in Railway Bridges, H. R. White. Engineering News-Record, vol. 80, no. 24, June 13, 1918, pp. 1137-1138, 2 figs. Linear formula for floor-beam concentration giving shears and moments easily.

Designing Wall Beams in Concrete Flat-Slab Buildings, Albert M. Wolf. Engineering News-Record, vol. 80, no. 24, June 13, 1918, pp. 1124-1126, 3 figs.

Equivalent Uniform Loads for Concrete Beams, Albert J. Becker. Engineering & Contracting, vol. 49, no. 26, June 26, 1918, pp. 633-635, 3 figs. Method of calculating special beams with partial or non-uniform loads.

Formulas for Calculating Thickness and Reinforcement for Concrete Conduit, L. Robert de la Mahotiere. Engineering & Contracting, vol. 49, no. 24, June 12, 1918, pp. 591-593, 4 figs. A translation from Le Génie Civil. Based on assumption of empty conduit supporting a uniform load on upper half; thickness of conduit constant.

MILITARY ENGINEERING

Condotta e Osservazione del Tiro Terrestre, Giuseppe Fioravanzo. Rivista Marittima, Anno 51, no. 3, March 1918, pp. 173-190, 11 figs. An extensive mathematical article on land artillery fire.

MUNITIONS

Routing and Handling Shells, James Forrest. Machinery, vol. 24, no. 10, June 1918, pp. 922-925, 8 figs. General production methods and short cuts on larger shells.

The Manufacture of the Lewis Machine Gun, X. The Bolt and Feed Operating Stud—I, Frank A. Stanley. American Machinist, vol. 49, no. 1, July 4, 1918, pp. 25-29, 9 figs. Description of the machining operations.

Forging the U. S. 75-Millimeter Shell, Erik Oberg. Machinery, vol. 24, no. 10, June 1918, pp. 890-897, 20 figs. Fourth of a series of articles describing approved methods employed in the forging and machining of the U. S. 75-mm. shell.

By-Product Coke Industry in War Time, William H. Blauvelt. The Iron Age, vol. 101, no. 24, June 13, 1918, pp. 1544-1545. Importance of the by-product method in coal conservation; furnishing raw materials for high explosives; keystone products, bases of important industries. From paper read before the American Iron and Steel Institute, May 1918.

Sidelights on Winchester Gun Production, W. E. Freeland. The Iron Age, vol. 101, no. 24, June 13, 1918, pp. 1521-1526, 9 figs. Control of tools and gages; foremen held responsible for inspection; time-study methods and satisfactory results.

POWER-PLANT ENGINEERING

Estimating Power Requirements of a Locality, Ludwig W. Schmidt. Power, vol. 48, no. 2, July 9, 1918, pp. 55-56.

PUMPS

A Log Book for an Electrically Driven Pumping Unit at New Bedford, R. C. P. Coggeshall. Journal of the New England Water Works Association, vol. 32, no. 2, June 1918, pp. 173-179, 1 fig., 1 chart.

Water-Works Pump with High Efficiencies. Power, vol. 48, no. 1, July 2, 1918, p. 16, 1 fig. Results of efficiency tests of two 12-in. motor-driven centrifugal pumps.

RAILROAD ENGINEERING

Standardization of Indian Railways' Locomotives, E. C. Poultney. Railway Age, vol. 64, no. 24, June 14, 1918, pp. 1425-1430, 9 figs., 3 tables.

*Tests with 2-10-2 Locomotive on the Union Pacific. Railway Age, vol. 64, no. 26, June 28, 1918, pp. 1573-1574, 3 figs.

Design and Maintenance of Locomotive Boilers. Railway Age, vol. 64, no. 25, June 21, 1918, pp. 1522-1523.

Semi-Elliptic Springs—Manufacture and Repair. Railway Age, vol. 64, no. 25, June 21, 1918, pp. 1528-1531, 10 figs.

*Small Locomotives of Special Types. The Engineer, vol. 125, no. 3239, June 14, 1918, pp. 507-510, figs. 19-26.

Feed Water Heaters, J. Snowden Bell. Railway Review, vol. 63, no. 1, July 6, 1918, pp. 14-16, 3 figs.

Norfolk & Western 267-Ton Mallet Locomotive, H. W. Reynolds. Railway Age, vol. 65, no. 2, July 12, 1918, pp. 59-63. Details of design of a 2-8-8-2 Mallet locomotive and tender built at the Norfolk & Western Shops, Roanoke, Va.

Local Stresses in Box Bolsters, L. E. Endsley. Railway Mechanical Engineer, vol. 92, no. 6, June 1918, pp. 343-348, 15 figs. Tests of loaded bolsters with Berry strain gage showing effect on strength of design details. Abstract of paper read before St. Louis Railway Club, May 1918.

The Railway Shop Tool Room, M. H. Williams. Railway Mechanical Engineer, vol. 92, no. 6, June 1918, pp. 335-340, 7 figs. The importance of the tool room and its equipment.

Drafting Modern Locomotives, H. W. Coddington. Railway Mechanical Engineer, vol. 92, no. 6, June 1918, pp. 331-333, 3 figs.; no. 7, July 1918, pp. 387-392, 10 figs. Improvements effected by a study of draft conditions on Norfolk & Western 4-8-2 type engines.

The Light Railway Along the British Front at Close Range, Robert K. Tomlin, Jr. Engineering News-Record, vol. 80, no. 25, June 20, 1918, pp. 1162-1169, 15 figs. Where and how lines are built; how maintained and how operated; what they have accomplished.

A Well-Organized Repair Shop. Railway Mechanical Engineer, vol. 92, no. 6, June 1918, pp 303-311, 15 figs. A study of methods followed in repairing locomotives on the New York Central at West Albany.

Reclamation on the Southern Pacific, Frank A. Stanley. Railway Mechanical Engineer, vol. 92, no. 7, July 1918, pp. 381-386, 12 figs. First installment. Describes the extensive salvage work done in the road's Sacramento shop.

Doings of the United States Railroad Administration. Railway Age, vol. 65, no. 2, July 12, 1918, pp. 48-57. Action of freight classification, valuation, mileage, etc.

REFRIGERATION

*Cold Accumulators and Their Application, Ernest S. H. Barrs. Power, vol. 48, no. 1, July 2, 1918, pp. 31-33, 2 figs.

Steel Frame Refrigerator Cars, E. G. Goodwin. Railway Mechanical Engineer, vol. 92, no. 7, July 1918, pp. 401-405, 10 figs. Description of Norfolk & Western design with bunched insulation, insulated bulkheads and conduit floor racks.

STEAM ENGINEERING

Interpreting Steam-Turbine Test Curves, H. E. Breisford. Power, vol. 47, no. 25, June 18, 1918, pp. 866-868, 5 figs. Brief description of standard turbine test curves and how they are derived and used in interpreting turbine characteristics.

*Effect of Feed-Water Temperature and Rate of Injection Upon Steam Flow, Frank G. Philo. Power, vol. 47, no. 26, June 25, 1918, pp. 915-916, 1 fig., 1 table.

Improving Plant Conditions, A. W. Blom. Power, vol. 48, no. 1, July 2, 1918, pp. 11-12, 4 figs. How changes were made to prevent air from leaking past the end of chain-grate stokers. Description of a feed-water heater working on the jet-condenser principle.

Remodeling the St. Louis Baden Station, K. Toensfeldt. Power, vol. 47, no. 25, June 18, 1918, pp. 862-865, 4 figs. Remodeling a station of 3300 boiler horsepower at a total investment cost of $177,500 for an estimated annual saving of $11,797.

Table of B.T.U.'s per Boiler Horsepower at Various Efficiencies, Charles H. Bromley. Power, vol. 48, no. 2, July 9, 1918, p. 46.

Some Causes of Boiler-Tube Failures, R. Cederblom. Power, vol. 48, no. 2, July 9, 1918, pp. 43-46, 4 figs. Theory advanced that failure of tubes through blistering is due to steam formation in the tube preventing the water from sweeping the tube surface and keeping it cool. How to minimize the trouble; influence of baffling on steam generated per square foot of tube.

Causes of Vacuum Trouble, L. F. Forseille. Power, vol. 47, no. 26, June 25, 1918, p. 909, 1 fig. An analysis of trouble experienced in the maintenance of a normal vacuum on a 10,000-kva. turbine unit equipped with a jet type of condenser.

Main and Auxiliary Steam Piping, Ralph W. Propert. The Journal of the American Society of Marine Draftsmen, vol. 5, no. 1, April 1918, pp. 9-11.

Soot Blowers for Horizontal Water-Tube Boilers. Power, vol. 48, no. 1, July 2, 1918, pp. 2-7, 19 figs. An extensive discussion of the subject of soot blowers with special reference to the different types of mechanical blowers on the market and their application to the various boilers in use.

Gaskets for Steam-Pipe Lines, Zeno Schultes. Power, vol. 48, no. 1, July 2, 1918, pp. 8-10, 4 figs. General discussion of the subject of packing for steam pipe lines. The author claims that flanged pipe joints are particularly apt to leak and explains it by the presence of rough flange faces, large bolt holes and holes spaced too far apart.

VARIA

American Chemists' Defensive Measures Against Gas Attacks in France, Robert K. Tomlin, Jr. Metallurgical and Chemical Engineering, vol. 18, no. 12, June 15, 1918, pp. 636-639, 3 figs.

Handling Materials at Hog Island, H. Cole Estep. The Marine Review, vol. 48, no. 7, July 1918, pp. 277-279, 313, 4 figs.

Evolutionary Business Principles, L. P. Alford. Industrial Management, vol. 56, no. 1, July 1918, pp. 8-9.

Vestibule Schools for the Unskilled, H. E. Miles. Industrial Management, vol. 56, no. 1, July 1918, pp. 10-12.

Boxing Machinery to Prevent Damage, Luther D. Burlingame. Industrial Management, vol. 56, no. 1, July 1918, pp. 27-33, 18 figs.

Tanks for Water Supply, Charles L. Hubbard, National Engineer, vol. 22, no. 7, July 1918, pp. 288-295, 18 figs., 1 table.

Army Lead in Waste Prevention and Utilization. Engineering News-Record, vol. 81, no. 1, July 4, 1918, pp. 25-26, 1 table.

L'Industrie du Chapeau de Paille en Lorraine. Société Industrielle de l' Est, Bulletin no. 138, May 1918, pp. 4-12. The straw-hat industry in Lorraine.

Youngstown Sheet and Tube Tandem Plate Mill. The Iron Age, vol. 101, no. 26, June 27, 1918, pp. 1660-1663, 6 figs. Description of continuous slab-heating furnaces and new type of plate turnovers. Capacity, 15,009 tons per month.

Intermediate Rate Fine-Sand Water Filter Operates Under Vacuum. Engineering News-Record, vol. 80, no. 26, June 27, 1918, pp. 1230-1232, 4 figs. Silty water after a 75-mile journey through

irrigating canals is clarified without chemical treatment to the extent of 3 million gallons daily.

Engineering Education as Applied to Naval Architecture and Marine Engineering, H. A. Everett. International Marine Engineering, vol. 23, no. 6, June 1918, pp. 337-342. From an address before the Delaware River Branch of the American Society of Marine Draftsmen, Feb. 1918.

Training Engineer Officers for the Army at Camp Lee, Frank C. Wight. Engineering News-Record, vol. 81, no. 1, July 4, 1918, pp. 12-15, 10 figs.

Compulsory Coöperation of Central Station and Isolated Plant, S. R. Sague. Power, vol. 47, no. 25, June 18, 1918, pp. 870-872. Correspondence with city officials of Cleveland, O., the Fuel Administration and others concerning the advisability of enforced coöperation of public-service and privately-owned plants, so as to avoid duplication of distribution systems and prevent waste of coal.

Early Attempts at Submarine Building, H. H. Manchester. American Machinist, vol. 48, no. 26, June 27, 1918, pp. 1081-1085, 10 figs. Attempts by former generations to devise submarine boats dating from 390-1800 A. D.

The Laws Guarding Machinery, Chesla C. Sherlock. American Machinist, vol. 49, no. 2, July 11, 1918, pp. 76-78.

The Lyons Fair. American Machinist, vol. 49, no. 2, July 11, 1918, pp. 68-70, 2 figs. Delayed correspondence dealing with the annual industrial exposition at Lyons, France.

War as a Test of Efficiency, Edward H. Hurley. American Machinist, vol. 49, no. 1, July 4, 1918, pp. 11-12.

Changes in American Machine-Tool Exports, L. W. Schmidt. American Machinist, vol. 49, no. 1, July 4, 1918, pp. 9-11. Changes in the industrial condition of our allies which must be taken into account in planning after-war business.

Factory Moving, L. J. Hengesbach. Machinery, vol. 24, no. 11, July 1918, pp. 999-1002, 5 figs. Methods of efficiently solving the problems arising when moving machinery into a new factory.

Training Women for the Drawing Room, Howard W. Dunbar and W. E. Freeland. The Iron Age, vol. 102, no. 1, July 4, 1918, pp. 1-5, 2 figs. Description of the successful teaching system employed by the Norton Grinding Co., and of the results secured.

LIBRARY NOTES AND BOOK REVIEWS

ARTICLES of interest from the Library of the four Founder Societies, selected list of accessions during the month, and reviews of books of special importance prepared by members of the A.S.M.E. and others particularly qualified.

BOOK NOTES

American Lubricants. From the Standpoint of the Consumer. By L. B. Lockhart. The Chemical Publishing Co., Easton, Pa., 1918. Cloth, 6x9 in., 236 pp., 13 illus., 44 tables. $2.

The purpose of this book is to aid the user of lubricants in the intelligent selection of oils and greases by giving facts and figures of value and excluding all irrelevant matters.

American Railway Accounting. A Commentary by Henry C. Adams. Henry Holt & Co., New York, 1918. Cloth, 5x8 in., 465 pp. $3.

Discusses the standard system of railway accounts promulgated for and used by American railways and is intended to explain the accepted rules to students of accounting and practical accountants.

Automobile Construction and Repair. A Practical Guide to the Design, Construction, and Repair of Automobile Mechanisms. By Morris A. Hall. American Technical Society, Chicago, 1918. Flexible leather, 711 pp., 6x8 in., 568 illus., 4 pl., 4 tables. $2.50.

Intended for mechanics engaged in automobile construction and repair. Describes the construction of the standard types of transmission, clutches, valves, etc., and gives methods for repairing the troubles that occur in operation.

Train Operation. A Treatise on Train Rules, Train Orders, Change of Time Table, Automatic Block Signals, Interlocking, Examination Questions and Answers. By William Nichols. Le Grand Brown, Rochester, N. Y., 1916. Flexible leather, 340 pp., 55 pl., $2.50. (flexible cloth. $2.)

An interpretation and amplification of the Rulings of the American Railway Association issued prior to November, 1915, and of the Standard Train Rules and other practices which have been found necessary in handling trains. Based on the author's experience as chairman of the Board of Examiners, Southern Pacific Co., but does not apply to any particular railroad.

The Fighting Engineers. The Minute Men of Our Industrial Army. By Francis A. Collins. The Century Co., New York, 1918. Cloth, 5x8 in, 220 pp., 31 pl. $1.30.

A popular account of the work of the American engineering regiments in France and America.

The Financing of Public Service Corporations. By Milton B. Ignatius. The Ronald Press Company, New York, 1918. Cloth, 6x9 in., 508 pp. $5.

This volume presents a comprehensive discussion of all the important aspects of public-service-corporation financing from the inception of the enterprise to the expenditure of the proceeds. Intended for corporation officials, public officers, bankers and brokers. Based on the work of the Public Service Commission of the Second District of New York.

Heating and Ventilation. By John R. Allen and J. H. Walker. First edition. McGraw-Hill Book Company, Inc., New York, 1918. Cloth, 6x9 in., 305 pp., 174 illus., 76 tables. $3.

Intended for use as a textbook in schools of engineering and architecture, and as a handbook by practising engineers.

Hiring the Worker. By Roy Willmarth Kelly. The Engineering Magazine Co., New York, 1918. Cloth, 6x9 in., 245 pp., 8 pl., 66 forms, 5 charts, 2 folded, 2 tables. $2.

A summary of the efforts of many firms to solve the problems of employment. Describes the theories and policies which have been tested, suggests the possibilities of employment management and attempts to point out the profitable avenues of advancement.

A History of Chemistry. By F. J. Moore. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6x8 in., 292 pp., 6 illus., 12 pl., 37 por., 8 diag., 5 tables. $2.50.

This volume is based on a course of lectures given to the senior students of chemistry in the Massachusetts Institute of Technology and is intended to provide a concise account of those facts and influences which have made the science what it is today. Suitable for mature students.

An Introduction to the Chemistry of Plant Products. By Paul Haas and T. G. Hill. Second edition. Longmans, Green and Co., New York, 1917. Cloth, 6x9 in., 411 pp., 5 illus. $3.50.

This work is an attempt to provide botanists with an account of the chemical and biological significance of the more important substances occurring in plants. The present edition has been revised as a whole and the section on plant pigments has been rewritten.

Modern Inorganic Chemistry. By J. W. Mellor. New edition. Longmans, Green and Co., New York, 1917. Cloth, 5x8 in., 910 pp., 334 illus., 64 tables. $2.50.

A general course in chemistry intended to develop skill in observation and experiment, memory and knowledge of relevant facts, ability to reason and think in a logical, systematic way, to cultivate the imagination and to develop a critical and impartial judgment.

Modern Locomotive Valve and Valve Gears. By Charles L. McShane. Griffin & Winters, Chicago, 1918. Cloth, 5x8 in., 339 pp., 113 illus., 1 folded pl. $2.50.

A practical discussion of the principles, construction and operation of the valves and valve gears of modern locomotives. Written in simple, non-mathematical language.

Northwest Mines Handbook. A Reference Work of the Mining Industry of Idaho, Washington, British Columbia, Western Montana and Oregon. By Sidney Norman. Vol. I. Published by author, Spokane, 1918. Cloth, 6x10 in., 366 pp. (advertising pages included), 28 illus., 9 por., 2 maps, 1 folded, 13 tables. $5.

Covers the mining enterprises which surround Spokane. Contains general descriptive articles on mining and geology of each state, statistics of production, gives lists of the mines and mining corporations, showing capital stock, property and development.

Over the Drawing Board. A Draftsmen's Hand Book. By Ben J. Lubschez. Journal of the American Institute of Architects, Washington, 1918. Cloth, 5x7 in., 131 pp., 22 illus., 9 pl. $2.

Contents: Introductory, Drafting Room, Equipment, Instruments, Mounting of Paper and Drawings, Tracing Paper and Tracing Cloth, Geometrical Short-cuts, Lettering, Titling, Numbering, Working Drawings, Indications, Lines, Sketches, Exhibition Drawings, Water Colors, Perspective, Filing of Drawings and Plates, Photography, the Reproductive Processes, Photo-Engraving, Etching, Wood Engraving, Lithography.

From his experience and observation, the author has selected convenient methods and short-cuts for draftsmen.

Popular Oil Geology. By Victor Ziegler. C. H. Merrifield, Golden, Col., 1918. Flexible cloth, 5x7 in., 149 pp., 62 illus., 1 pl. $2.50.

An exposition of the fundamental principles of oil geology, intended for men without technical training who are interested in the subject.

Regulation of Railways. Including a Discussion of Government Ownership Versus Government Control. By Samuel O. Dunn. D. Appleton and Co., New York, 1918. Cloth, 5x8 in., 354 pp., 5 tab. $1.75.

Contents: What is the Matter with Railway Regulation? Functions of Government in Relation to Railways, Commission versus Legislative Regulation, Federal versus State Regulation, Regulation of Rates, Valuation in Relation to Regulation of Rates and Securities, Regulation of Securities, Regulation of Railway Operation, Peaceful Settlement of Labor Disputes or Strikes? Government Regulation versus Government Ownership, Some Practical Phases of Government Ownership, The Failure of Government Ownership in Canada.

A general presentation of the methods that have been advocated and of the actual effects of rate regulation.

Rubber. Its Production, Chemistry and Synthesis in the Light of Recent Research. A Practical Handbook for the Use of Rubber Cultivators, Chemists, Economists and Others. By A. Dubosc and Dr. A. Luttringer. English Edition by Edward W. Lewis. J. B. Lippincott Co., Philadelphia, 1918. Cloth, 6x9 in., 383 pp., 51 tables. $6.50.

The authors have collected into a single volume all the scattered writings relating to the cultivation or the modern chemistry of rubber, with the addition of their own observations on these subjects. Much attention is given to the various proposed processes for the synthesis of rubber.

Scientific Management. A History and Criticism. By Horace Bookwalter Drury. Second edition, revised. Studies in History, Economics and Public Law; Edited by the Faculty of Political Science of Columbia University. Vol. 65, No. 2. Whole Number 157. Columbia University, New York, 1918. Paper, 6x10 in., 251 pp. $2.

A history of the origins and development of scientific management, with a critical review of its important aspects. Brief biographies of the leaders in the movement are given, and its relation to labor is discussed. The present edition has been largely extended and revised. The statements have been brought down to date, and the conclusions have been rewritten in a number of cases.

Strength of Materials. A Comprehensive Presentation of Scientific Methods of Locating and Determining Stresses and Calculating the Required Strength and Dimensions of Building Materials. By Edward R. Maurer. American Technical Society, Chicago, 1918. Cloth, 5x8 in., 126 pp., 2 pl., 7 tables. $1.

An elementary presentation of the subject, in which the use of higher mathematics has been avoided.

Standard Wiring for Electric Light and Power. As adopted by The Fire Underwriters of the United States, in Accordance with This Year's Edition of the National Electrical Code, with Explanations, Illustrations and Tables Necessary for Outside and Inside Wiring and Construction for All Systems, Together with a Special Section on House Wiring. By H. C. Cushing, Jr. H. J. Cushing, Jr., New York (copyright, 1918). Flexible cloth, 4x7 in., 360 pp. (advertising pages included), 4 illus., 21 diag., 37 tables.

This edition of the essential rules and requirements for safe and efficient wiring and construction for electric heat, light and power follows the plan adopted in former editions, but has been revised to meet present requirements.

A Text-Book of Inorganic Chemistry. Edited by J. Newton Friend. Vol. 5; Carbon and Its Allies, by R. M. Caven. J. B. Lippincott Co., Philadelphia, 1917. Cloth, 6x9 in., 468 pp., 15 illus., 70 tables, 1 folded, 1 chart.

Contents: Introductory, Carbon and its Compounds, Silicon and its Compounds, Titanium and its Compounds, Zirconium and its Compounds, Thorium and its Compounds, Germanium and its Compounds, Tin and its Compounds, Lead and its Compounds.

The aim of this series is to provide a comprehensive textbook of inorganic chemistry, sufficiently complete for ordinary purposes, and supplied with numerous references to the leading works and memoirs.

Tire Making and Merchandising. A Book of Facts Concerning Manufacturing Processes, Illustrating the Principal Tire Types, Rims and Non-Skid Treads, with Chapters on Rubber and Other Factors Governing Tire Costs, Present and Future Trend of the Market, Merchandising for Profit, Dividends from Service, Marketing Methods and Sales Campaigns, Tire Equipment of All Pleasure and Commercial Cars from 1913 to Present Date, and a Dealers' Dictionary of Terms. By F. R. Goodell. U. P. C. Book Company, New York, 1918. Flexible cloth, 5x8 in., 222 pp., 42 illus., 6 tables, maps, 7 diag. $2.

A compact summary of information on tire manufacture, marketing and merchandising, designed especially for those engaged in tire business.

Topography and Strategy in the War. By Douglas Wilson Johnson. Henry Holt and Co., New York, 1917. Cloth, 6x9 in., 211 pp., 33 pl., 18 maps. $1.75.

The author's objects have been to emphasize the effect played by land forms in plans of campaign and movements of armies in the great war, and to place before the reader a picture of each theater of war that will enable him to follow with intelligence the movements of the troops.

Wooden Shipbuilding. A Comprehensive Manual for Wooden Shipbuilders, to Which is Added a Masting and Rigging Guide. Compiled by W. J. Thompson. A. C. McClurg & Co., Chicago, 1918. Flexible cloth, 5x7 in., 202 pp., 2 tables. $2.50.

Contents: Wooden Ships, Masts and Rigging, Methods of Masting, Tables of Rigging. A book of pocket size, compiled from standard authorities. Chiefly intended as a glossary of the parts of ships and their rigging, with brief descriptions of the methods of construction, arranged in dictionary form.

Electric Furnaces in the Iron and Steel Industry. By W. Rodenhauser, J. Schoenawa and C. H. Vom Baur. Translated from the original by the latter and now completely rewritten. Second edition. John Wiley & Sons, Inc., New York, 1917. Cloth, 6x9 in., 429 pp., 134 illus., 2 pl., 24 tables. $3.75.

A review of the electrical furnaces used in iron smelting, and of the processes employed. The present edition contains minor revisions covering certain changes since 1913.

Tycos Mineral Oil Tables. Taylor Instrument Companies, Rochester, N. Y., 1918. First edition. Cloth, 4½x6½ in., 204 pp. $1.

A useful and handy collection of gravity and temperature tables for mineral oils—from determinations of the Bureau of Standards, together with other tables for general testing and refinery practice, including viscosity, water density, steam, ammonia and humidity tables, as well as tables for the conversion of weights and measures, and various physical and chemical tables. The book also contains instructions for testing oils.

Correction.—The price of A. N. Goldsmith's Radio Telephony is $2 instead of $1.25, as stated in the June issue.

ACCESSIONS TO THE LIBRARY

ALUMINUM: Its history, occurrence, properties, metallurgy and applications, including its alloys. Edition 2. By Joseph W. Richards. *Philadelphia, 1890*. Gift.

ALUMINUM AND ITS CONGENERS, including the rare earth metals. By H. F. V. Little. Vol. IV of Text-book of Inorganic Chemistry. *London, 1917*. Purchase.

CHEMISTRY OF PERMUTIT. *New York, 1917*. Gift of Arthur Worischek.

CITY OF NEW YORK. President of the Borough of Manhattan. Report of the Business and Transactions for the year ending Dec. 31, 1916. Gift of President of the Borough of Manhattan.

CONSTRUCTION DES AÉROPLANES. Résistance des Matériaux. By F. Orain. *Paris, n. d.* Purchase.

DYNAMICS OF MECHANICAL FLIGHT. Lectures delivered at the Imperial College of Science and Technology, March, 1910 and 1911. By Sir G. Greenhill. *London, 1912*. Purchase.

ENGINEERING SOCIETY OF CHINA. Proceedings. Vols. 15-16. *Shanghai, 1916-17*. Gift of Engineering Society of China.

THE ENGINEER'S YEAR-BOOK OF FORMULAE, RULES, TABLES, DATA AND MEMORANDA, 1918. Compiled and edited by H. R. Kempe. *London, 1918*. Purchase.

GOLD DEPOSITS OF THE RAND. By C. B. Horwood. *London, 1917*. Purchase.

GOLD INDUSTRY AND GOLD STANDARD. By Hennen Jennings. Gift of American Mining Congress.

HEALTH AND WAR. By Irving Fisher. (From *American Labor Legislation Review*, vol. 8, no. 1, 1918.) Gift of Irving Fisher.

MANUEL POUR L'ESSAI DES COMBUSTIBLES ET LE CONTROLE DES APPAREILS DE CHAUFFAGE. By F. Fischer. *Paris, 1902*.

THE MERRILL PROCESS OF INDUSTRIAL HEATING. *Fitchburg, Mass., n.d.* Gift of The G. M. Parks Co.

METAL MARKET YEAR-BOOK, "The Ironmonger," 1918. *London, 1918*. Purchase.

MODERN COKING PRACTICE. Vols. 1-2. Ed. 2. By J. E. Christopher. *London, 1917*. Purchase.

THE MOTOR, MARINE AND AIRCRAFT RED BOOK, 1917. Compiled by W. C. Bersey and A. Dorey. *London, 1917*. Purchase.

NATIONAL SOCIETY FOR VOCATIONAL EDUCATION. Problems of Administering the Federal Act for Vocational Education. (Bulletin No. 26.) *New York, 1918*. Gift of National Society for Vocational Education.

NATIONAL TEXTILE EXPOSITION (6th). Grand Central Palace, April 29-May 11, 1918. Gift of Textile Exhibitors Association.

NEW YORK STATE CHARITIES AID ASSOCIATION. Annual Report for the year ending Sept. 30, 1917. *New York, 1917*. Gift of Association.

NEW YORK STATE CONSERVATION COMMISSION. Annual Report, 5th, 1915. *Albany, 1917*. Gift of Conservation Commission.

NOMENCLATURE FOR AERONAUTICS. Report No. 15. National Advisory Committee for Aeronautics. *Washington, 1918*. Gift of National Advisory Committee for Aeronautics.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS. Transactions. Vol. XXXIII. *Newcastle-upon-Tyne, 1917*. Purchase.

NOVA SCOTIA. Department of Public Works and Mines. Annual Report of the Mines, 1917. *Halifax, 1918*. Purchase.

PENNSYLVANIA STATE BOARD OF CENSORS. Report for the year ending Nov. 30, 1917. *Harrisburg, 1917*. Purchase.

PORTLAND CEMENT ASSOCIATION. Catalog of books, periodicals and pamphlets in the library. *Chicago, 1918*. Gift of Association.

PRODUCTION OF ELLIPTIC INTERFERENCES IN RELATION TO INTERFEROMETRY. Parts I-II. By Carl Barus. *Washington, 1911-12*. Gift of Carnegie Institution of Washington.

RÉSISTANCE DES MATÉRIAUX. By Ch. De Mussan. *n. p. n. d.*

STEAM TABLES FOR CONDENSER WORK. Ed. 4. *Carteret, N. J., 1915*. Gift of Wheeler Condenser & Engineering Co.

STRUCTURAL SERVICE BOOK. Volume I. A revised reprint from the twelve issues for 1917 of the *Journal of the American Institute of Architects*. *Washington, 1918*. Gift of American Institute of Architects.

SURFACE WATER SUPPLY OF THE UNITED STATES, 1916. Part I—North Atlantic slope-drainage basins. (U. S. Geological Survey. Water Supply Paper No. 431); Part VII. Lower Mississippi River Basin. (U. S. Geological Survey. Water Supply Paper No. 437.) *Washington, 1918*. Purchase.

SOCIETY OF BRITISH GAS INDUSTRIES. Presidential address by Sir Robert Hadfield. April 18, 1918. Gift of Sir Robert Hadfield.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS. Transactions, 1917. Vol. 25. *New York, 1918*. Purchase.

SUBMARINES. A list of references in the New York Public Library. Compiled by Mary Ethel Jameson, with a foreword by Simon Lake. *New York, 1918*. Gift of New York Public Library.

TABULAR CLASSIFICATION OF IGNEOUS ROCKS. By Victor Ziegler. *n. d.* Gift of author.

TORPEDOES. A list of references to material in the New York Public Library. Compiled by William A. Ellis. *New York, 1917*. Gift of New York Public Library.

WHO'S WHO, 1918. *London-N. Y., 1918*. Purchase.

GIFT OF ILLUMINATING ENGINEERING SOCIETY.

A COLLECTION CONSISTING OF SEVENTY-EIGHT BOOKS, PAMPHLETS AND SOCIETY PUBLICATIONS.

GIFT OF RED CROSS INSTITUTE FOR CRIPPLED AND DISABLED MEN

DEVELOPMENT IN ENGLAND OF A STATE SYSTEM FOR THE CARE OF THE DISABLED SOLDIER. By John C. Faries.

ORGANIZATION, WORK AND METHOD OF THE RED CROSS INSTITUTE FOR CRIPPLED AND DISABLED MEN. By Douglas C. McMurtrie.

RECONSTRUCTING THE CRIPPLED SOLDIER. By Douglas C. McMurtie.

REHABILITATION OF THE WAR CRIPPLE. By Douglas C. McMurtrie.

VOCATIONAL REËDUCATION FOR WAR CRIPPLES IN FRANCE. By Grace S. Harper.

TOURVIELLE: A TRADE SCHOOL FOR WAR CRIPPLES. By Gustave Hirschfeld.

TRADE CATALOGUES

CENTRALIZED BALL MILL COMPANY. San Francisco, Cal.
Theory and Practice of Ball Milling. Descriptive circular.

CLEVELAND MILLING MACHINE COMPANY. Cleveland, Ohio.
Stock List of Cutters, June 15, 1918.

CROCKER WHEELER COMPANY. Ampere, N. J.
Bulletin No. 183. Motor Drive for Printing Machinery. April, 1918.
Bulletin 184. Direct Current Lighting and Power Generators. March, 1918.
Bulletin 185. Coupled and Belt Types of Alternating Current Generators. March, 1918.

GAERTNER, WM., & COMPANY. Chicago, Ill.
Catalog S. T. O. Universal Laboratory Supports, Balances, Weights, Glassware and Supplies. 1918.

GENERAL ELECTRIC COMPANY. Schenectady, N. Y.
Bulletin No. 46018A. Portable Instruments, Type P-8. 1918.

GENERAL ELECTRIC COMPANY. Schenectady, N. Y.
Class 317, No. 68202. CR 3100 Drum Type Controllers for Series, Shunt or Compound Wound Motors. 1918.

MANUFACTURING EQUIPMENT & ENGINEERING COMPANY. Boston, Mass.
Metal Equipment, Price-List, March 15, 1918.
Sanitary Drinking Fountains. Partial List of Users.
Sanitary Bubbling Fountain with Ice-Cooled Water Supply for Shop, Factory, Office and General Use.
Sanitary Washbowls (Dept. A).

MONARCH ENGINEERING & MANUFACTURING COMPANY. Baltimore, Md.
The New Monarch Vertical Non-Crucible Tilting Metal-Melting Furnace. Descriptive Booklet.

POOLE ENGINEERING & MACHINE COMPANY. Baltimore, Md.
Folder 200-04, 206, 208-214. Turbogear. May, 1918.

STANDARD SHOP EQUIPMENT COMPANY. Philadelphia, Pa.
CAD Nuts, Bolts, Clamps, etc. Illustrated Folder.